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Measurement of Cadmium, Lead, Zinc, and Calcium in Selected Populations in the United States

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MEASUREMENT OF CADMIUM, LEAD, ZINC, AND CALCIUM IN SELECTED POPULATIONS IN THE UNITED STATES

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16. ABSTRACT

As part of a continuing national and international survey of cadmium ingestion, a study was performed to estimate the daily intake of cadmium and other metals in two low-income populations in the U.S.: rural blacks and urban hispanics of Mexican-American heritage. More than 260 persons were recruited and surveyed. Feces, urine, and blood were collected from each participant and analyzed for Cd, Pb, Zn, Ca, and Fe; blood was also analyzed for iron-binding capacity and hemoglobin; and urine was also analyzed for beta$_2$-microglobulin and creatinine.

Results indicate that ingestion rates of cadmium in both populations are slightly lower than levels reported previously for the general U.S. population, and ingestion rates of lead are considerably lower (less than one half) than levels reported previously for the general population. It was concluded that nonoccupational exposures of these two population groups to cadmium and lead through ingestion is no greater than and is probably less than that experienced by the general population of the United States.

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FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The complexities of environmental problems originate in the deep interdependent relationships between the various physical and biological segments of man's natural and social world. Solutions to these environmental problems require an integrated program of research and development using input from a number of disciplines. The Health Effects Research Laboratory, Research Triangle Park, NC and Cincinnati, OH, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. Wide ranges of pollutants known or suspected to cause health problems are studied. The research focuses on air pollutants, water pollutants, toxic substances, hazardous wastes, pesticides, and non-ionizing radiation. The laboratory participates in the development and revision of air and water quality criteria and health assessment documents on pollutants for which regulatory actions are being considered. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of environmental regulatory decisions involving the protection of the health and welfare of all U.S. inhabitants.

This report documents a study performed to estimate the daily intake of two toxic metals, cadmium and lead, in two population groups in the United States thought to be at potentially higher risk to these metals due to low socioeconomic circumstances: rural blacks and urban hispanics. The results of the study indicate that ingestion rates of cadmium and lead in each of the two study populations are no greater and possibley less than rates reported previously for the general population os the United States.

F. Gordon Hueter, Ph.D.
Director
Health Effects Research Laboratory

ABSTRACT

As part of a continuing national and international survey of cadmium ingestion, a study was performed to estimate the daily intake of cadmium and other metals in two low-income populations in the U.S.: rural blacks and urban hispanics of Mexican-American heritage. More than 260 persons were recruited and surveyed. Feces, urine, and blood were collected from each participant and analyzed for Cd, Pb, Zn, Ca, and Fe; blood was also analyzed for iron-binding capacity and hemoglobin; and urine was also analyzed for beta$_2$-microglobulin and creatinine.

Results indicate that ingestion rates of cadmium in both populations are slightly lower than levels reported previously for the general U.S. population, and ingestion rates of lead are considerably lower (less than one half) than levels reported previously for the general population. It was concluded that nonoccupational exposures of these two population groups to cadmium and lead through ingestion is no greater than and is probably less than that experienced by the general population of the United States.

This study was conducted through the support of the Health Effects Research Laboratory of the U.S. Environmental Protection Agency under Cooperative Agreement CR 806939.

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SECTION 1

INTRODUCTION

BACKGROUND

Cadmium (Cd) and lead (Pb) are classified according to their electronic configurations as "d-block" and "p-block" metals, respectively, neither of which has any biochemical functions essential to good health. Both metals are toxic at low concentration, Cd more so than Pb (Friberg et al., 1979).

The half-life of Cd and Pb in the body is estimated to range from 5 to 30 years. Increased accumulation of Cd in the body will eventually lead to proteinuria, renal tubular damage, kidney failure, osteomalacia and nerve dysfunctions. Elevated accumulations of Pb in the body may lead to anemia, gastrointestinal dysfunctions, encephalopathy, neuropathy and nephropathy. The "target" organ for Cd is the kidneys while bone appears to be the "target" organ for Pb (Friberg et al., 1979).

Industrialized countries have continually increased their use of Cd and Pb which has resulted in an increased risk-of-exposure for both occupationally and nonoccupationally exposed populations (Nriagu, 1980). This increased risk-of-exposure comes from both industrial products and pollution. Industrial pollution has increased the concentration of these metals in water, air, soil and food. Atmospheric pollution of Cd and Pb is expected to increase in the U.S., as coal and lignite replace petroleum feedstocks as our major energy sources (National Academy of Sciences, 1980; Nriagu, 1980; Yost, 1979). Another important source of Cd and Pb exposure has been cigarette smoking, which statistics indicate is increasing in teenagers and women (Evans et al., 1979; Harris, 1979). One pack of cigarettes contains the equivalent of 25 μg of Cd from dietary sources (Naylor and Loehr, 1981) when relative absorption rates are accounted for. It is estimated that smoking 30 cigarettes per day will provide an average of 15 μg of absorbed Cd to the body (National Academy of Sciences, 1980).

Investigations of acute exposure episodes to Cd pollution (Friberg et al., 1974) have stimulated an interest in the biochemistry of Cd (Singhal et al., 1979; Aylett, 1979) and have focused attention on the health effects caused by long-term exposure to low concentrations of Cd in the diets of different populations. Recent studies on Pb pollution have been concerned with the health effects caused by exposure to exhaust fumes from the combustion of leaded gasolines and from point sources, such as lead smelters, coal-fired power plants, and battery reclamation plants (National Academy of Sciences, 1980).

Cadmium data from two recent studies have been extracted and summarized by Kowal et al. (1979). These data can be considered as background Cd levels in two regionally different (Chicago, Illinois and Dallas, Texas) nonoccupationally exposed populations. The first of these studies examined the health effects caused by the release of heavy metals and pathogenic organisms from a sewage treatment plant located near an urban area (Johnson et al., 1978a). The other study investigated the Cd and Pb (plus two other metals) concentrations in tissue samples (autopsy) from accidental death victims and also the Cd ingestion rates (fecal measurement) of a living population from the same area as the accident victims (Johnson et al., 1978b). These studies were part of an international round-robin evaluation, involving Japanese, Swedish, and American investigators, to determine Cd analytical methodologies. The results of this round-robin evaluation have been published (Kjellstrom, 1979).

Selected populations which have an increased exposure level to Cd and Pb (plus other metals) have been studied. A study conducted in Houston, Texas examined exposure levels to automobile exhaust fumes of traffic policemen, parking garage attendants, and housewives living near busy expressways. These exposed populations were compared to control populations with similar characteristics (Johnson et al., 1974). Another study tried to determine if there were correlations between traffic densities and blood-Pb levels of people living near streets with various traffic densities (Johnson et al., 1978c). Other studies have examined exposure of the general populace to point-sources of toxic metal pollution (Landrigan et al., 1975; Roberts et al., 1974).

These studies and others from the literature are important in estimating the health risks to the populations studied and also in providing a data base to which other populations may be compared.

Cadmium and lead in our environment comes from many different natural and manmade sources. The input from natural sources are not significant when compared to the anthropogenic sources. For example, the estimated Cd input into the atmosphere from natural sources (windblown dust, volcanic emissions, etc.) is less than 10 percent of the total (Nriagu, 1980). Industrial operations remain the largest sources of metal pollution to the environment. Waste disposal from industry accounts for over 7.0 x 10^8 g of Cd per year (Nriagu, 1980), while emissions of Pb amount to over 3.0 x 10^9 g per year--not including gasoline combustion input (National Academy of Sciences, 1972).

The use of Pb-based insecticides for crop protection through the mid-1970's and the extensive use of fertilizers containing traces of Cd, Pb, and other metals have increased the concentration of these metals in soils and surface and ground waters through leaching processes and runoffs. In

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urban areas combustion of gasoline has increased Pb concentrations in air and soils near roadways. There are some indications that atmospheric levels of Pb are decreasing as leaded gasoline is being phased out in the U.S. (National Academy of Sciences, 1980; Heidorn et al., 1981).

The application of sewage sludge to crop lands has been practiced for many years in this country. Presently about 25 percent of all municipal sludges are applied to land (Pahren et al., 1979). This presents another source of toxic metals to the environment and a direct link with the food chain when applied to crop lands (Naylor and Loehr, 1981).

Since Cd and Pb are accumulated by certain vegetables and grain crops and dietary intake is a major source of exposure to the general population, the risk of increased exposure to these metals is reflected in the increased contamination of the environment. The average daily ingestion via food in noncontaminated areas has been estimated to range from 10 to 50 μg for Cd (Kjellstrom, 1978) and between 100 and 500 μg for Pb (National Academy of Sciences, 1980). Using a market basket approach, the U.S. Food and Drug Administration has estimated the median American diet to contain 39 μg of Cd per day (Naylor and Loehr, 1981). Recent studies in nonindustrially polluted urban areas of the U.S. have estimated daily dietary intake of Cd to range from 12 to 24 μg/day by measuring Cd in human feces (Kowal et al., 1979). It has been estimated that adult Americans absorb 29 μg of Pb every day from atmospheric and dietary sources (Settle et al., 1980).

Absorption percentages for Cd and Pb are estimated to be only 4 percent and 9 percent (approximate), respectively, and these absorption percentages are influenced by various dietary factors. Studies have indicated that vitamins, minerals, and other trace metals can influence the absorption of Cd and Pb. For example, levels of Ca, Cu, Fe, Zn and vitamin C in the diet will affect the absorption rate of Cd and Pb (Thawley et al., 1977; Levander et al., 1980; Fox et al., 1980; Mahaffey et al., 1980). Elevated absorption rates due to iron deficiency, protein deficiency, or decreased levels of Ca in the diet could provide tissue exposure to Cd and Pb at toxic levels from diets that are otherwise within normally acceptable limits.

Because estimates of daily ingested rates approach recognized toxic levels, the quantities of Pb and Cd ingested in the United States are of concern. Some studies (Johnson et al., 1975; Johnson et al., 1978b; Tipton et al., 1969; Food and Drug Administration, 1977) have provided estimates for cadmium and lead by a "market basket" approach and by measurement of the metals in human feces. More data are needed to assess possible effects of geographic, socioeconomic, ethnic, sex and urban versus rural differences. Three high risk groups have been identified among the various population groups within the United States. These are vegetarians, high-rate consumers of shellfish, and poor black and hispanic populations. This study was designed to survey ingestion rates and associated health effects in the latter group. The survey addresses two very specific population groups: low socioeconomic rural blacks and low socioeconomic urban hispanics. These populations are potentially at higher risk than the general population because low socioeconomic status limits the ability to select certain foods and provides a bias for grains, grain products, and vegetables known to contain higher levels of cadmium (Naylor and Loehr, 1981). Food preferences in the two ethnic groups may also provide a further tendency for consumption of the higher cadmium foods. This tendency may be accentuated for blacks in rural areas where traditional food preferences may be less affected by recent social changes. In urban communities with concentrated hispanic populations of Mexican-American heritage, the prevalence of Mexican food in the daily diet is well known.

A number of very distinctive hispanic populations are residents in various areas of the U.S. These include persons of Mexican heritage, Puerto Rican heritage, Cuban heritage, and others. It is recognized that no one of these heritages is completely representative of all persons of hispanic heritage residing in the United States. However, to provide the study with some degree of homogeneity in the selected hispanic population, only one of these heritages was utilized--persons of Mexican-American heritage. Persons of Mexican-American heritage are the most numerous among the various nationalities of the hispanic populations in the United States, they are more widely dispersed among the various states and regions of the U.S., and there continues to be a greater influx of hispanic immigrants from Mexico than from any other source of hispanic populations.

OBJECTIVES

The general objective of this study was to estimate the ingestion rates of cadmium and lead in two subgroups of the U.S. population, low socioeconomic rural blacks and low socioeconomic urban hispanics, and to evaluate the evidence of cadmium toxicity. The specific objectives to accomplish this general objective were:

1) select specific study populations from the two subgroups of the U.S. population;

2) obtain fecal, blood, and urine samples and diet, health, and smoking history information from the selected study population;

3) measure levels of cadmium and lead in the fecal samples and estimate daily ingestion rates of cadmium and lead;

4) measure levels of cadmium and lead in the urine and blood samples to provide data relative to recent exposures and to estimate body burdens;

5) measure levels of calcium and zinc in the fecal samples to evaluate the possible effect on cadmium status;

6) measure iron in feces and serum, total iron binding capacity, and hemoglobin to evaluate iron deficiency;

7) measure beta$_2$-microglobulin in urine to evaluate for evidence of cadmium toxicity. It has been shown that during cadmium-induced

proteinuria there are large excretions of beta$_2$-microglobulin. Elevations of protein have been seen in populations with high fecal and urinary levels of cadmium;

8) measure creatinine and specific gravity levels in urine for use in adjusting urinary parameters for urine concentration;

9) determine significant patterns regarding ingestion rates, body burdens, iron deficiency, and cadmium toxicity in the study populations with regard to ethnicity, age, sex, smoking history, and dietary habits and compare these findings to results for the general U.S. population.

DESIGN

The design of this study was to recruit 240 study participants, 120 in each of two population subgroups in the United States as shown in the following table:

TABLE 1. STUDY POPULATION DESIGN

		Number of participants	
Sex	Age	Urban hispanics	Rural blacks
Male	young 12-18	30	30
	old 50+	30	30
Female	young 12-18	30	30
	old 50+	30	30
		120	120

The study populations were forcused into two age groups to provide some homogeneity regarding age and age-related potentially confounding factors. Age is an important characteristic which influences exposure levels due to lifestyles and eating habits and which is related to susceptibility. The increase of cadmium levels in tissue with increasing age is well documented (Kowal et al., 1979). In order to provide the opportunity for observing differences related to age, two age groups were selected: a young age group with ages ranging 12 to 18 years and an older age group with ages of 50 or more years. The ages of 12 to 18 years are important growth years with high consumption of foods and building of much tissue, potentially cadmium laden. Because tissue cadmium is known to increase with age, the older group is considered to have a high susceptibility to continued cadmium exposure. Selection of these two age

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groups provided a study population with high susceptibility and with a sufficient spread in ages for observation of age effects.

Census statistics were used to select one urban and one rural community as study sites to provide sufficient numbers of low socioeconomic populations of the required ethnic types. Within each selected study site, specific recruitment areas were designated which exhibited particularly uniform socioeconomic and ethnic characteristics of the desired types. In general, all residents of the designated recruitment areas who met age and ethnic requirements were considered eligible.

Study participants were recruited through personal contacts by trained recruitment workers. Use was made of civic organizations, church groups, and schools in the selected study sites. Potential volunteers were met at schools or community centers and briefed on the objectives of the study. Informed consent was obtained through the use of a specially designed form. Volunteers were provided a package which contained sample collection containers for urine and feces samples and instructions for storage. Blood samples were collected by medically trained and licensed personnel at the school or community center. Study participants collected and stored urine and feces samples over a weekend and delivered the samples to the study team on the following Monday. Health, dietary, smoking, and personal background information were collected from each participant via interview with use of a specially designed health history record form.

Each participant provided the following samples:

two 10-mL vacutainers of blood,
two 24-hour stool samples,
one 24-hour urine sample.

The following measurements were performed on the samples collected:

Sample type	Analysis
feces	Cd, Pb, Zn, Ca, Fe, and weight
blood	Cd, Pb, Fe, total iron-binding capacity, and hemoglobin
urine	Cd, Pb, beta$_2$-microglobulin, specific gravity, creatinine, and volume

The study was conducted during an 18-month period, beginning February 1980. Samples were collected during the period June to October 1980.

SECTION 2

CONCLUSIONS

An important objective of this study was to determine the ingestion rates of cadmium and lead in two specific population groups in the United States, urban hispanics and rural blacks, to compare these levels to levels previously reported for the general U.S. population, and to determine whether these two population groups are at high risk to these toxic metals. Study results are similar for the two study populations. Ingestion rates of cadmium in both populations are comparable to but slightly lower than levels reported previously for the general population. Ingestion rates of lead are considerably lower (less than one half) than levels reported previously for the general population. It is concluded from the results that nonoccupational exposures of these two population groups to cadmium and lead through ingestion is no greater than and is probably less than that experienced by the general population of the United States.

A second important objective of the study was to evaluate the evidence of cadmium toxicity. It is concluded from the study results that little or no evidence of cadmium toxicity has been found for either of the two study populations.

In addition to these major conclusions, a number of secondary conclusions have been drawn from the study results:

1) There is no apparent iron deficiency in either of the study populations.
2) Smokers tended to exhibit higher levels of urine cadmium than nonsmokers in both study populations.
3) Food consumption habits in both study populations do not appear to be oriented to the higher cadmium foods.
4) A relatively high rate of heart disease and high blood pressure was self-reported by the older black female study population.
5) A relatively high rate of kidney disease was reported by the older black population.
6) No correlation with cadmium levels in blood, urine, or feces was detected for the populations with higher reported heart, blood pressure, or kidney disease.
7) Because no unusually high cadmium levels were found in the study populations, the potential for zinc or calcium compounds to influence cadmium status was not addressed.

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SECTION 3

RECOMMENDATIONS

The results of this study do not lead to a recommendation for follow-up studies of either of the two selected populations at risk.

SECTION 4

METHODS AND PROCEDURES

PREPARATIONS FOR DATA COLLECTION

Selection of the Study Sites

Conduct of the study required identification, selection, and recruitment of 240 volunteers, 120 of each of two population subgroups in the United States as discussed in Section 1. To meet these requirements, two study sites were required: one in an urban setting, populated by a high percentage of persons with an hispanic heritage or language, and a second in a rural setting populated by a high percentage of black people. A further requirement for these study sites was that the resident populations exhibit low socioeconomic characteristics.

Study site requirements applied to this study are summarized in Table 2. These site selection criteria include specification of urban/rural location, ethnicity, socioeconomic status, and presence of local support. In addition, to minimize transportation costs and increase the ability to coordinate field activities, ease of access to the main campus of Southwest Research Institute in San Antonio was a factor in site selection.

The site selection criteria were applied and study sites were selected in the following general manner:

1) Census data were examined.
2) Public agencies were contacted.
3) Potential sites were determined.
4) Contacts were made with local organizations by telephone.
5) Candidate sites were selected and visited.
6) Findings were reviewed and evaluated.
7) Final sites were selected.

Census data for the 1970 census of the population of the United States provided basic data on socioeconomic indicators, numbers of residents, and urban/rural classification for potential study sites. Median family income and median number of years of education for persons 25 years or older were selected as the socioeconomic indicators applicable to site selection.

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TABLE 2. SITE SELECTION CRITERIA

1. Urban Site Location

   The urban site must be located in a notably urban setting within one of the Standard Metropolitan Statistical Areas (SMSA) defined by the U.S. Census Bureau.

2. Rural Site Location

   The rural site must be located in a notably rural setting outside a designated SMSA.

3. Ethnicity

   A high percentage of the resident population of the site must be of the required ethnic type, with sufficient numbers to support the study.

4. Socioeconomic Status

   The resident population of the site must exhibit low socioeconomic status as measured by median family income and median number of years of education for persons of 25 years of age and older.

5. Local Support

   A commitment for sufficient support of the study by local civic and other organizations must be obtained before final selection of the study site.

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These two parameters are the most commonly used socioeconomic indicators because they reflect two different and important population characteristics--purchasing power and acquired knowledge--and are readily available from census records. The study sites selected were to exhibit numbers for these indicators significantly below U.S. median values. The median U.S. family income in 1969 was $9,590 per annum; the U.S. median number of school years completed by persons over 25 years of age was 12.2 years.

The Texas Department of Health was contacted for assistance in selecting study sites. The epidemiology section provided aid in evaluating the potential for use of specific communities in the study. Particularly appropriate information regarding presence or absence of state health department offices and indications of expected community response were provided by Department of Health personnel.

Using the criteria outlined, a number of potential study sites were determined from census data and supplementary information. For urban hispanics, the most outstanding potential sites were San Antonio, Texas and two Standard Metropolitan Statistical Areas (SMSA) in the Texas Rio Grande Valley: Brownsville-Harlingen-San Benito and McAllen-Pharr-Edinburg. For rural blacks, several counties in eastern Texas and several in the delta area of Mississippi were most apparent as potential sites. Contacts with local organizations in San Antonio, Marion County, and San Augustine County, Texas led to site visits in each of these areas. The existence of support facilities and the degree of support from local organizations was determined during the site visits. After evaluation of the findings, two study sites were selected: San Antonio, Texas for urban hispanics and Marion County, Texas for rural blacks. Detailed discussions for the characteristics of each of these sites are discussed as follows.

San Antonio, Texas--

An area near the western edge of the central business district of San Antonio, Texas was selected as the study site for low income, urban hispanics. San Antonio is a highly urbanized area with a population of more than one million persons in the metropolitan area. The city and the surrounding region of Texas have historically had a high percentage of hispanic residents because San Antonio was a significant center of commerce and government when Texas was a part of Mexico (prior to 1836) and because of San Antonio's proximity to Mexico and the Texas Rio Grande Valley (less than 150 miles). Approximately one half of the city's current residents are of hispanic ancestry or language.

The specific site selected for this study includes four census tracts defined for use in the 1970 census. This area of San Antonio can be termed a "barrio" or Spanish-speaking neighborhood with a very high percentage (more than 95 percent) of lower income hispanic residents. In Table 3 some characteristics of the selected census tracts are compared with characteristics of the U.S. total, Texas total, and the Rio Grande Valley of Texas, an area with an historically high percentage of hispanic

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populations with low income. The four census tracts have a population of approximately 26,000 residents. The data in Table 3 show that the study site has an extremely high hispanic population, exceeding even the Rio Grande Valley. The 1970 census data show the income levels in the study site to be comparable to those in the Rio Grande Valley. It is significant that the SMSA's in the Texas Rio Grande Valley were ranked economically among the lowest in the U.S. per 1970 census data. Median income levels in the study site were approximately 57 percent of the value for the general population of Texas and 50 percent of the national median family income. The median number of school years completed in the study site was approximately 50 percent of the value for the general population of Texas and 47 percent of the national median value.

Excellent support for the on-site recruitment and sampling operations was identified and arranged. A social action organization, the Mexican-American Unity Council (MAUC), was contracted for support of the study. The principal office of this organization is located in one of the four census tracts selected for the study, and the population served by MAUC is primarily that for which the study is designed--low income persons of Mexican heritage living in the study site area. A community meeting room at the principal MAUC offices was made available for recruitment and sampling activities and MAUC agreed to allow the study to be promoted to the Mexican-American community under the blanket of MAUC approval. The availability of medical resources in the San Antonio area for obtaining blood sampling personnel and the ease of access of the study site to the main campus of Southwest Research Institute ten miles away were also considered in selection of the study site.

Marion County, Texas--

A portion of Marion County, Texas was selected as the study site for low income, rural blacks. Marion County is located in northeastern Texas, adjacent to the border with Louisiana. This region of the United States has long been agriculturally oriented. Plantation farming of cotton and other crops in the area dates from before the civil war. The area has been historically comprised of a high percentage of blacks, approaching or exceeding 50 percent in many communities.

Marion County exhibits many of the traits associated with this part of rural America. The county is primarily rural, with a population of 8,517 in 1970. The principal town and county seat is Jefferson, Texas, population 2,866 in 1970. Some 45 percent of the population of the county is black. During the 1978 school year, 477 black students (56 percent of the total enrollment) were enrolled in grades 7 through 12 in the local school district. In Table 4, data for Marion County are compared with similar data for the U.S. total, Texas total, and the delta region of Mississippi, an area considered to be high in percentage of blacks with low income. From Table 4, it is seen that Marion County has a high percentage of black population compared to Texas and the U.S. and is somewhat similar to the percentages associated with counties located in the Mississippi delta area. Median income levels in Marion County are very comparable to

TABLE 3. HISPANIC STUDY SITE CHARACTERISTICS (1970 Census)

Geographic area	% Hispanic population	Median family income General	Median family income Hispanic	Median school years General	Median school years Hispanic
United States	4.6	9,590	7,534	12.2	10.8
Texas	18.4	8,490	5,897	11.6	8.5
Lower Rio Grande Valley, Texas					
Cameron County	76.2	5,068	4,074		5.8
Hidalgo County	78.4	4,776	3,958		4.9
Starr County	97.6	3,593	3,593		6.0
Willacy County	75.8	4,156	3,348		4.5
San Antonio, Texas (near west side)					
Tract 1702	97.8	4,386	4,386		5.8
Tract 1703	98.3	4,730	4,730		5.0
Tract 1707	98.3	5,426	5,426		6.3
Tract 1712	98.3	4,908	4,908		6.1

TABLE 4. RURAL BLACK STUDY SITE CHARACTERISTICS (1970 Census)

Geographic area	% Black population	Median family income General	Median family income Black	Median school years General	Median school years Black
United States	11.1	9,590	6,067	12.2	10.0
Texas	12.4	8,490	5,334	11.6	9.8
Mississippi (delta area)					
Adams County	47.9	6,915	3,430		7.6
Amite County	50.4	4,224	2,600		7.3
Franklin County	38.8	4,800	2,555		6.6
Lincoln County	30.7	5,646	3,451		7.7
Pike County	43.5	5,284	3,487		7.7
Wilkinson County	67.6	3,882	2,794		6.3
Texas (rural northeast)					
Marion County	45.0	5,224	2,666		8.1

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the delta area and are approximately 50 percent of the value for the general population of Texas and 43 percent of the national median family income. The median number of school years completed in the study site was slightly higher than those exhibited by the delta area, 8.1 versus a range of 6.3 to 7.7, but was significantly lower than values for Texas and the U.S. (69 percent of the Texas median value and 66 percent of the national median).

Because of its rural, agricultural, and low income characteristics, Marion County was considered a good site for this study. The Texas Department of Health regional office in Tyler, Texas, Dr. M. Crowder, regional director, offered to support the project activities by allowing the project staff to operate out of the health department office in Jefferson, Texas. Dr. Wilmer West, the physician in charge of the Jefferson office, made that office available to study staff during the on-site activities. Other significant support of the study was obtained from one local hospital and two local community organizations. The Douglas Memorial Hospital, Dr. C. A. Darby, physician-in-charge, provided medical personnel and other support for the study activities. Two community centers serving predominantly black residential areas were enlisted to support the study and were used for recruitment and sampling activities. The Marion County Education and Recreation Center is located in the predominantly black west end of Jefferson and serves that portion of the community. The Smithland Community Center serves a predominantly black rural community in Marion County, some 13 miles east of Jefferson. These two community centers and the residential areas in their vicinities were the focal points of the study site.

Preparation of Information Record Forms

Two record forms were developed and used in the study to collect information from participants: one to record informed consent of each participant and a second to record health and dietary information. The two forms are presented and discussed in the following section.

The informed consent form shown in Figure 1 was developed to document the informed consent of each participant. The form was designed to provide potential participants with a brief summary of the study purpose, a description of the study requirements for information and biological sampling from each participant, and an indication of any potential risk or hazard to the individual. The form is self-explanatory and was reviewed in person with each participant at the time of his or her enrollment into the study to ensure their understanding of the study requirements and hazards. A signed and witnessed informed consent was obtained from all participants in this study. For minor subjects, the form was reviewed with both the subject and a designated responsible adult and signatures were obtained from both.

The health history form was designed to give information in four subject areas:

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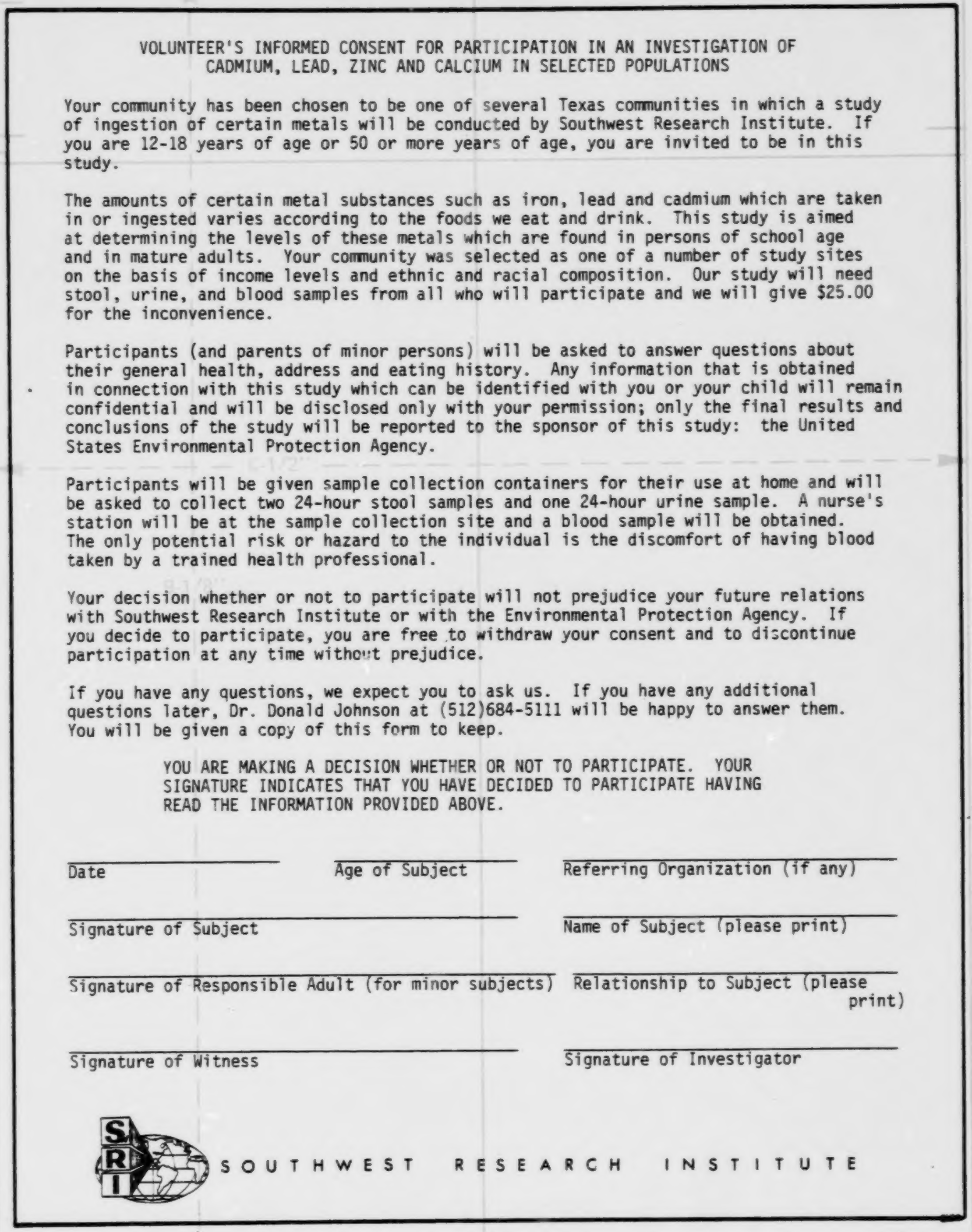

VOLUNTEER'S INFORMED CONSENT FOR PARTICIPATION IN AN INVESTIGATION OF CADMIUM, LEAD, ZINC AND CALCIUM IN SELECTED POPULATIONS

Your community has been chosen to be one of several Texas communities in which a study of ingestion of certain metals will be conducted by Southwest Research Institute. If you are 12-18 years of age or 50 or more years of age, you are invited to be in this study.

The amounts of certain metal substances such as iron, lead and cadmium which are taken in or ingested varies according to the foods we eat and drink. This study is aimed at determining the levels of these metals which are found in persons of school age and in mature adults. Your community was selected as one of a number of study sites on the basis of income levels and ethnic and racial composition. Our study will need stool, urine, and blood samples from all who will participate and we will give $25.00 for the inconvenience.

Participants (and parents of minor persons) will be asked to answer questions about their general health, address and eating history. Any information that is obtained in connection with this study which can be identified with you or your child will remain confidential and will be disclosed only with your permission; only the final results and conclusions of the study will be reported to the sponsor of this study: the United States Environmental Protection Agency.

Participants will be given sample collection containers for their use at home and will be asked to collect two 24-hour stool samples and one 24-hour urine sample. A nurse's station will be at the sample collection site and a blood sample will be obtained. The only potential risk or hazard to the individual is the discomfort of having blood taken by a trained health professional.

Your decision whether or not to participate will not prejudice your future relations with Southwest Research Institute or with the Environmental Protection Agency. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without prejudice.

If you have any questions, we expect you to ask us. If you have any additional questions later, Dr. Donald Johnson at (512)684-5111 will be happy to answer them. You will be given a copy of this form to keep.

YOU ARE MAKING A DECISION WHETHER OR NOT TO PARTICIPATE. YOUR SIGNATURE INDICATES THAT YOU HAVE DECIDED TO PARTICIPATE HAVING READ THE INFORMATION PROVIDED ABOVE.

Date ______ Age of Subject ______ Referring Organization (if any) ______

Signature of Subject ______ Name of Subject (please print) ______

Signature of Responsible Adult (for minor subjects) ______ Relationship to Subject (please print) ______

Signature of Witness ______ Signature of Investigator ______

SOUTHWEST RESEARCH INSTITUTE

Figure 1. Informed consent form

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1) personal information;
2) dietary habits;
3) medical history;
4) smoking habits.

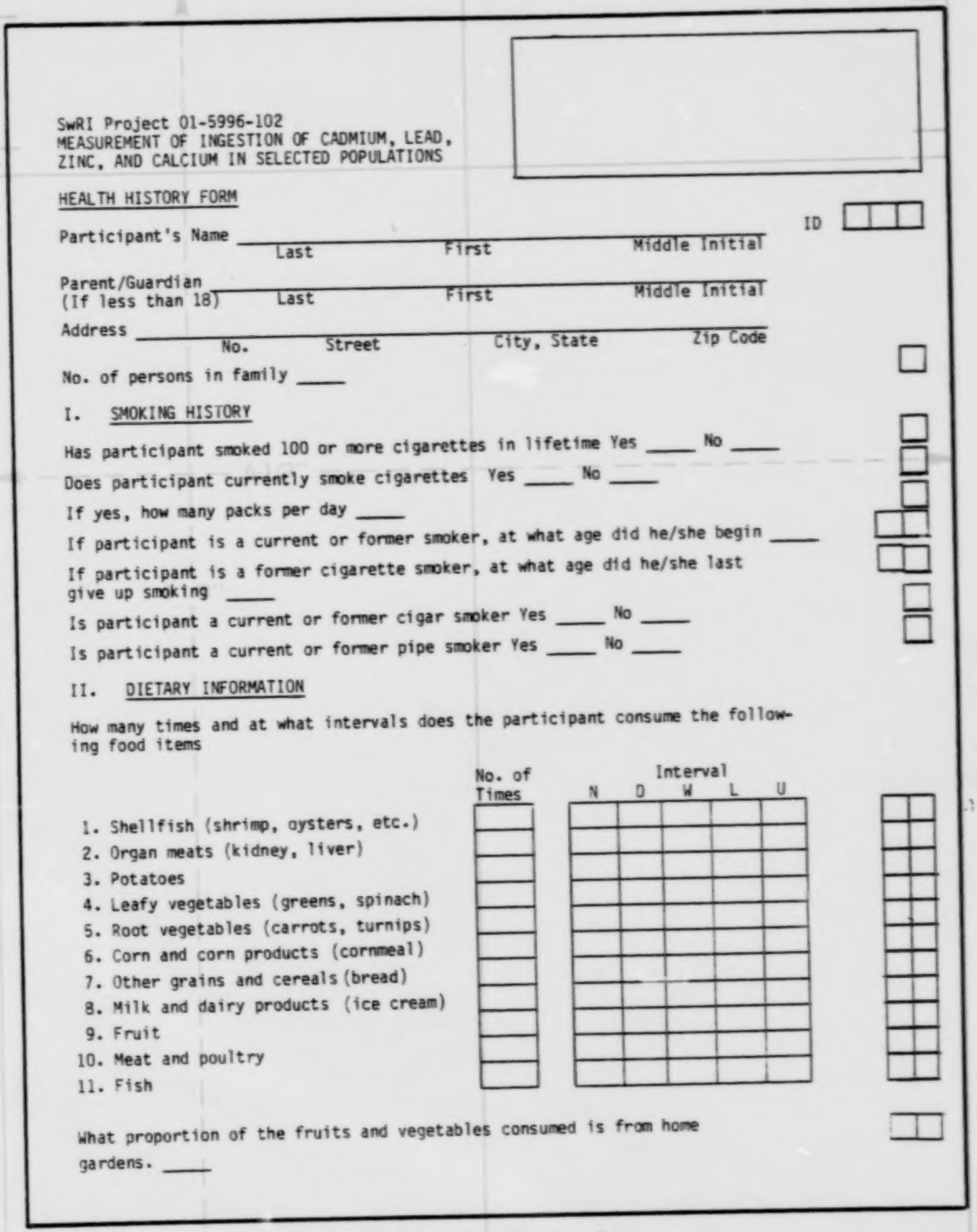
The personal information sought related to the socioeconomic characteristics of the participant and was intended to show that the subject qualified as a member of the study group. The information desired included age, sex, ethnic group, education of head of household, family income, length of residence in the study area, and occupation. The dietary information sought was the frequency with which the individual consumed the principal dietary sources of Cd, the frequency of use of dietary supplements, and whether the individual was following a special diet of any sort. Medical history sought concerned whether the individual had suffered from one of a number of diseases or conditions that could be a result from high Cd levels. The smoking information sought related primarily to cigarette smoking, with a token response on pipes and cigars. A copy of the form used is shown in Figure 2.

Personal information was designed primarily to verify that the participants satisfied the criteria for participation in the study. The ethnic group, length of residence, education of head of household, and family income information were included to characterize the population. Occupation was requested to disqualify any participants who might have been occupationally exposed to cadmium. Similarly, pregnancy is reported to have an effect on the metal levels in women. Because of the potential sensitivity of this question, the interviewer did not ask the participants but was instructed merely to record if the participant was noticeably pregnant.

The dietary information was concerned with the frequency of intake of the primary sources of cadmium from the food chain. Corn and corn products were separated from the rest of the cereal grains with the rationale that it might be an area of differentiation between the two study groups, owing to the frequency of use of corn products in the traditional Mexican-American foods.

The frequency reporting scheme used was that of a national health survey. In addition to providing data comparable to other studies, the proper use of this scheme would allow the interviewer to record the answer exactly as the participant gave it (i.e., twice a day, once a week, etc.). Additional questions concerned what proportion of fruits and vegetables consumed came from home gardens, use of dietary supplements, and whether the individual was following a specific diet.

For medical history, the participant was asked whether he had been treated for seven classes of medical problems that could result from high concentrations of Cd (Nriagu, 1980; Mennear, 1979). The term "treated" was specified to provide assurance that the condition actually existed, as



SwRI Project 01-5996-102
MEASUREMENT OF INGESTION OF CADMIUM, LEAD,
ZINC, AND CALCIUM IN SELECTED POPULATIONS

HEALTH HISTORY FORM

ID ☐☐☐

Participant's Name ________________ Last First Middle Initial

Parent/Guardian (If less than 18) ________________ Last First Middle Initial

Address ________________ No. Street City, State Zip Code

No. of persons in family _____ ☐

I. SMOKING HISTORY

Has participant smoked 100 or more cigarettes in lifetime Yes _____ No _____ ☐

Does participant currently smoke cigarettes Yes _____ No _____ ☐

If yes, how many packs per day _____ ☐

If participant is a current or former smoker, at what age did he/she begin _____ ☐☐

If participant is a former cigarette smoker, at what age did he/she last give up smoking _____ ☐☐

Is participant a current or former cigar smoker Yes _____ No _____ ☐

Is participant a current or former pipe smoker Yes _____ No _____ ☐

II. DIETARY INFORMATION

How many times and at what intervals does the participant consume the following food items

	No. of Times	Interval N	Interval D	Interval W	Interval L	Interval U	
1. Shellfish (shrimp, oysters, etc.)	☐	☐	☐	☐	☐	☐	☐☐
2. Organ meats (kidney, liver)	☐	☐	☐	☐	☐	☐	☐☐
3. Potatoes	☐	☐	☐	☐	☐	☐	☐☐
4. Leafy vegetables (greens, spinach)	☐	☐	☐	☐	☐	☐	☐☐
5. Root vegetables (carrots, turnips)	☐	☐	☐	☐	☐	☐	☐☐
6. Corn and corn products (cornmeal)	☐	☐	☐	☐	☐	☐	☐☐
7. Other grains and cereals (bread)	☐	☐	☐	☐	☐	☐	☐☐
8. Milk and dairy products (ice cream)	☐	☐	☐	☐	☐	☐	☐☐
9. Fruit	☐	☐	☐	☐	☐	☐	☐☐
10. Meat and poultry	☐	☐	☐	☐	☐	☐	☐☐
11. Fish	☐	☐	☐	☐	☐	☐	☐☐

What proportion of the fruits and vegetables consumed is from home gardens. _____ ☐☐

Figure 2. Health history form

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Does participant take dietary supplements for the following minerals.

	No	Yes, irregulary	Yes, regularly
Iron	____	____	____
Calcium	____	____	____
Multivitamins with iron	____	____	____
Multivitamins without iron	____	____	____

Is participant on a special diet. Yes ____ No ____
(vegetarian, reducing, diabetic, ulcer, etc.)

If yes, describe the diet. ______________________________

If yes, how long have they been following this diet. ____ yrs

III. MEDICAL HISTORY

Has the participant been treated for the following medical problems

	Yes	No	Yr. Treated First	Yr. Treated Last	Description
Kidney disease					
Liver disease					
Heart disease					
High blood pressure					
Cancer					
Anemia/low blood count					
Bone disease					

IV. PERSONAL INFORMATION

Age ____
Sex ____
Body weight ____
Ethnic group ____

How long has participant lived at current address (yrs) ____

If less than two years, how long in general study area ____

What kind of work does participant do most of the time

____

Education of head of household:

Years of school attended ____
High school graduate Yes ____ No ____
College attended or degree Yes ____ No ____

What is family income before taxes (thousands/year)

0-5____ 5-10____ 10-15____ 15-20____ >20____

Check if participant is noticeably pregnant. ____

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opposed to a self-diagnosis. If the answer was yes to any of the problems, the participant was asked to tell when he was treated, first and most recently, and to describe the condition further.

The form was prepared, reviewed by the project officer, revised, and submitted to the project officer for approval. A medical officer and a survey statistician from the EPA-Health Effects Research Laboratory reviewed the form and made comments and recommendations on its content and on the structuring and ordering of questions. Several of these comments were incorporated into the form and others were used as a basis for an interviewer guide that was prepared to aid the interviewer in obtaining the desired information.

Review Committee Regarding Human Subjects

Because the health effects survey documented here involved use of human subjects, the experimental protocol and the forms used to collect information were subject to review and approval by an appropriate review committee. Accordingly, a description of the study protocol and copies of the consent form and health history form were submitted to the Institutional Review Board of the University of Texas Health Science Center at San Antonio. Southwest Research Institute is one member of a consortium of research establishments and universities in the San Antonio area which coordinates all review and approval of human research projects through the referenced review board. Approval of the study protocol was granted by the review board on January 8, 1980.

Recruitment and Sampling Materials

Preparations for recruitment and sampling activities included development of printed materials for recruitment purposes, preparation of precoded labels for use with samples and forms, preparation of sample container kits for as many as 240 participants, and development of a system for guiding each study participant toward completion of all study requirements. Each of these preparation tasks is discussed as follows.

Recruitment Materials--

An outline of the study, indicating sponsor organizations, study sites, and participation requirements, was prepared for use in telling the story of the study to other organizations to inform them and to solicit cooperation where needed. For use in recruiting individual participants, one-page study summaries were developed separately for each of the two study areas: San Antonio and Marion County. In addition to outlining the study and participation requirements, the recruitment summaries indicated a time and place for meeting with the study team to obtain further information and volunteers for participation. Copies of these recruitment materials are presented in Appendix A.

Precoded Label System--

A computer-generated label system was developed for use on printed recruitment materials and on sample and subsample containers. A set of

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preprinted, peel-off labels was generated for each participant and coded with a unique participant number. The concept was to have a unique participant number available on a peel-off label so no given number would be assigned to more than one participant and all sample containers for a given participant would bear the same unique number. The labels were designed to display four distinctive pieces of information:

1) participant ID number;
2) sample or subsample alphanumeric identifier;
3) SwRI project number: 5996;
4) label use: one English word.

The participant ID number was a three-digit number from 001 to 199 for San Antonio participants and from 201 to 399 for Marion County participants. The sample/subsample alphanumeric identifier scheme was as follows:

Label identifier	Type of specimen	Sample/subsample use
F1,F2	Feces	2 24-hour samples
U1	Urine	1 24-hour sample
B1,B2	Urine	2 subsamples for beta$_2$-microglobulin analysis
M1,M2	Urine	2 subsamples for metals analysis
C1,C2	Urine	2 subsamples for creatinine analysis
T1,T2	Blood	2 samples of whole blood
I1,I2	Blood	2 samples of whole blood for spinning to separate out blood serum

In addition to these 13 types of labels, labels were generated with the captions: COOLER, CARD, and FORM. These three labels were used to identify the sample container kit provided to each participant and to identify a participant card and a health history form with the unique participant ID number. Labels for the cooler, card, and form for feces samples F1 and F2 and for urine sample U1 are depicted in Figure 3 for participant 398. This participant number was not utilized in the study.

Sample Container Kit--

A sample container kit was prepared for distribution to each participant. The kit included an ice chest with two cold packs for storage of samples, two feces containers with attached apparatus for placing in toilet, and one urine container. A shopping bag was also placed in the cooler for use in returning the sample containers. Precoded labels were placed on the ice chest and the sample containers, and a copy of the health history form with precoded label was placed inside the ice chest. An instruction sheet for sample collection and storage was included in the chest. A copy of the instruction sheet is presented in Appendix B with photographs of the sample container kit and its contents and of the proper

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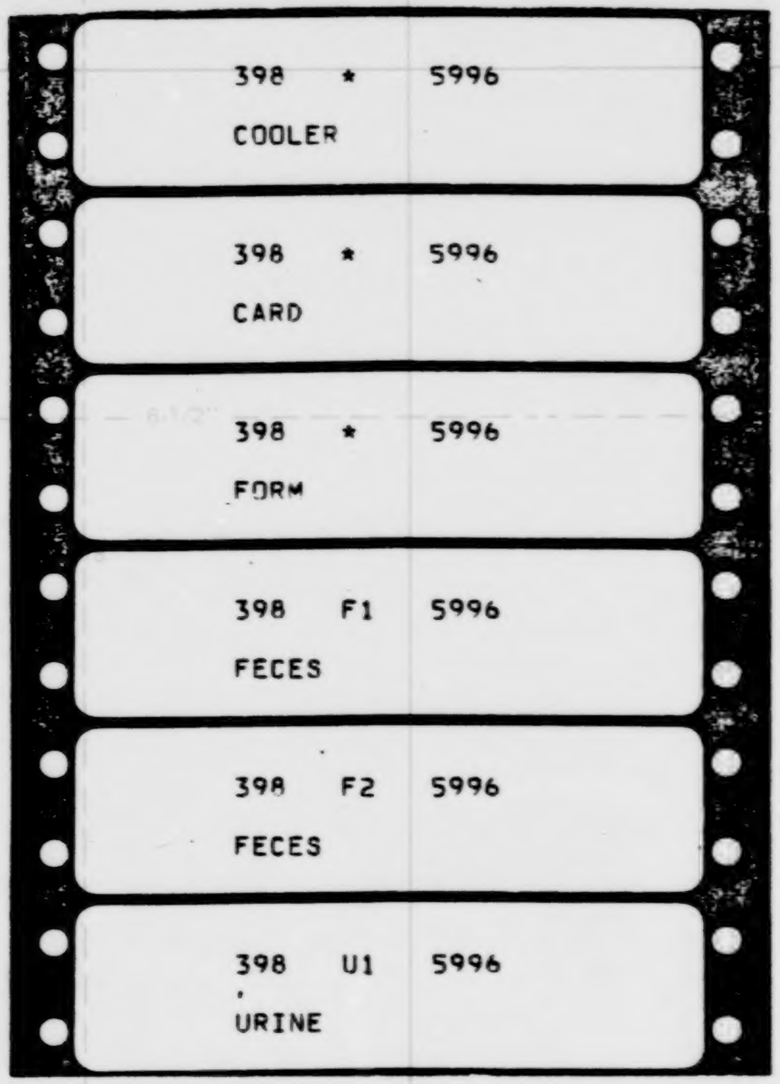

```
398    *    5996
COOLER

398    *    5996
CARD

398    *    5996
FORM

398    F1   5996
FECES

398    F2   5996
FECES

398    U1   5996
URINE
```

Figure 3. Computer-generated labels

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placement of the feces container and attached apparatus on the toilet. The photographs and instruction sheets presented in Appendix B were used during the study to instruct the participants regarding sample collection and storage.

Participant Card--

A most significant event in the study was the development and use of a card to record participant progress and status through the various stages of the recruitment and sampling activities. The card covered six differing information types and provided for a record check of 12 specific items to be completed for each participant. The participant card is depicted in Figure 4. The card provides space for attachment of the precoded ID label and has space for the participant's name to be recorded. Provision is made for a study team member to initial each major item completed by the participant.

This card greatly simplified the tracking of participants through recruitment and sampling. At times, more than 100 participants were at various stages of completion, and the participant card served as a "passport" for each participant and was used as a report card to establish completion status. When all portions of the participant card were complete and initialed by a study team member, the card was used by the participant to obtain his or her $25 compensation check.

CONDUCT OF THE SURVEY

The Survey Team

A multidisciplinary team was assembled, as depicted in Figure 5. The team consisted of a survey director, an assistant survey director, a sample collection coordinator, a blood sampling coordinator, and recruitment coordinators. All members were of the permanent staff at SwRI with the exception of the licensed medical professionals (RN, LVN, or medical technologists) retained for blood sampling and the recruitment coordinators retained on site in each of the study areas.

The duties of the survey direct[illegible] and assistant survey director were to provide general direction of [illegible]e various survey activities, to review and document adequate informed consent, to collect health history information, to maintain participant logs regarding completion status, and to provide payment of the $25 compensation to participants. The sample collection coordinator was responsible for distribution of the sample collection kits and instructions regarding proper sample collection, collection and storage of returned samples, maintenance of sample logs, and transport of the samples to the laboratories at SwRI. The blood sampling coordinator was responsible for overseeing the blood collection activity. He managed the activities of two or more licensed medical professionals, maintained logs of samples collected, prepared samples for transport, and transported the blood samples to the laboratories at SwRI. The recruitment coordinators were temporary employees retained to recruit participants in

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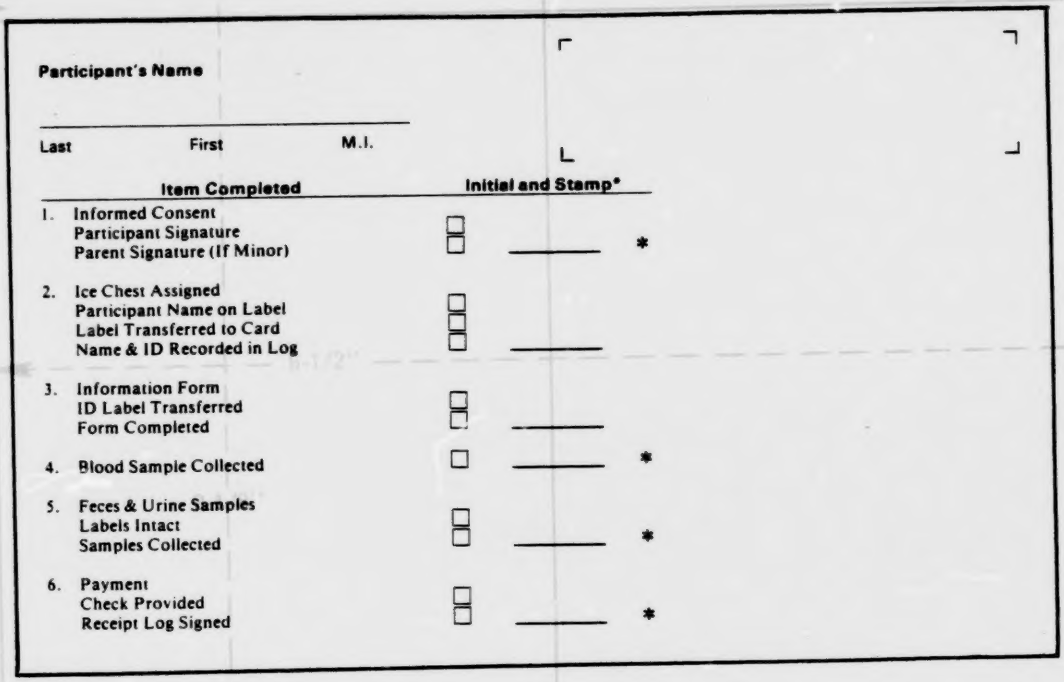

Participant's Name

Last First M.I.

Item Completed		Initial and Stamp*	
1. Informed Consent			
Participant Signature	☐		
Parent Signature (If Minor)	☐	________	*
2. Ice Chest Assigned			
Participant Name on Label	☐		
Label Transferred to Card	☐		
Name & ID Recorded in Log	☐	________	
3. Information Form			
ID Label Transferred	☐		
Form Completed	☐	________	
4. Blood Sample Collected	☐	________	*
5. Feces & Urine Samples			
Labels Intact	☐		
Samples Collected	☐	________	*
6. Payment			
Check Provided	☐		
Receipt Log Signed	☐	________	*

Figure 4. Participant card

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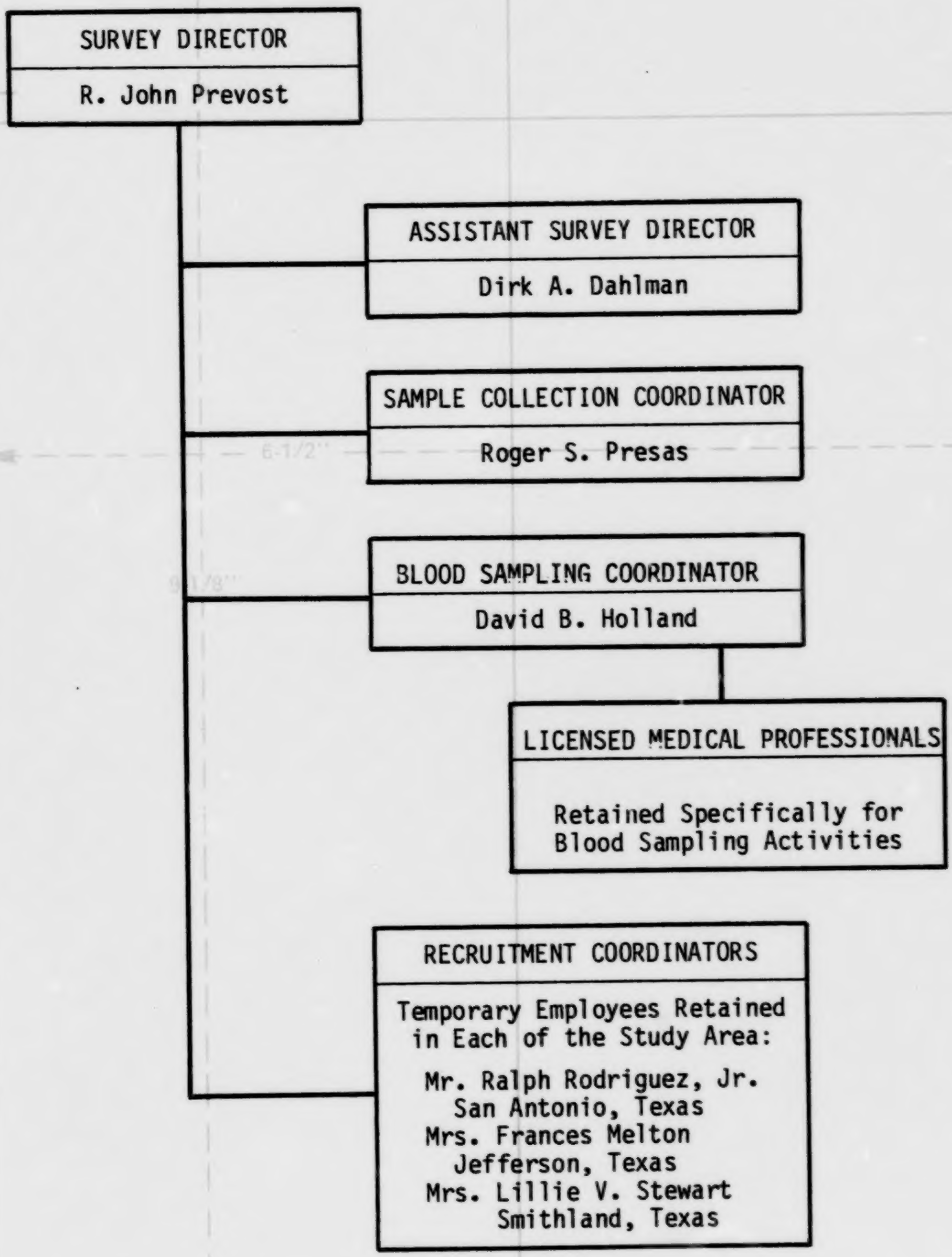
SURVEY DIRECTOR
R. John Prevost
ASSISTANT SURVEY DIRECTOR
Dirk A. Dahlman
SAMPLE COLLECTION COORDINATOR
Roger S. Presas
BLOOD SAMPLING COORDINATOR
David B. Holland
LICENSED MEDICAL PROFESSIONALS
Retained Specifically for Blood Sampling Activities
RECRUITMENT COORDINATORS
Temporary Employees Retained in Each of the Study Area:
Mr. Ralph Rodriguez, Jr.
San Antonio, Texas
Mrs. Frances Melton
Jefferson, Texas
Mrs. Lillie V. Stewart
Smithland, Texas

Figure 5. The survey team

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each study area. Prior to the scheduled sampling activities, the recruitment coordinators were responsible for recruiting volunteers who were residents of the selected study areas and who met study requirements regarding age, sex, and ethnic background. During the scheduled meeting with volunteers, the recruitment coordinators served as focal points for communication with participants, acted to guide participants through the various activities, and collected health history information.

Recruitment of Participants

Study participants were recruited in a similar manner in each of the study sites. Local support was sought and obtained from community organizations before final selection of the study sites. This local support is considered essential to the conduct of a study such as this. In San Antonio, the Mexican-American Unity Council provided significant aid to the recruitment activities. In Marion County, the local office of the Texas Department of Health, the Douglas Memorial Hospital, and community center organizations in Jefferson, Texas and in the Smithland area of Marion County all provided significant aid.

A local site coordinator was retained in each of the study site areas: San Antonio, Jefferson, and Smithland. These local site coordinators were responsible for arrangement for the use of local facilities during sampling activities and were in charge of recruiting volunteers from among the residents of the selected study areas. The site coordinators provided the study with a team member in residence at all times at the study site to muster local support and provide a source of information regarding the study to potential recruits.

The site coordinators were provided training and materials to support their function as recruitment coordinator in each area. Instructions as to the study requirements regarding the specific age, sex, ethnic, and income requirements for volunteers, the provision that volunteers are free to quit the study at any time, requirements for blood, urine, and feces samples and health related personal information from each participant, and the commitment for $25 compensation to all participants providing a complete set of samples and information were reviewed with each of the coordinators. Copies of the appropriate recruitment materials for the specific area and blank copies of the study informed consent (Appendix A) were provided to each coordinator. Methods of addressing individuals or groups of potential participants were reviewed with the coordinators.

Each recruitment coordinator was given a target number of qualified volunteers to the study to be recruited. For the single coordinator in San Antonio, this goal was 120 individuals evenly divided among the four age-sex groups. For each of the two coordinators in Marion County, this goal was 60 individuals. Because pregnancy is reported to affect metal levels, an attempt was made to exclude pregnant women, but all others meeting age, sex, and residency requirements were considered qualified for the study. The coordinators addressed the task by meeting with church and community groups in their assigned areas and by visiting individual homes. The informed consent form (Figure 1) was used to enroll volunteers. The form was reviewed with the potential volunteers and completed consent forms were collected by the coordinators. Recruitment forms (Appendix A) indicating the time and place of scheduled recruitment and sampling meetings were left with volunteers and were posted in appropriate buildings. The recruitment coordinators also telephoned individual recruits to inform or remind them of the scheduled meeting at the designated community center. Recruits were given the following information regarding the scheduled meeting:

1) Need to have completed and witnessed informed consent form;
2) Survey team would be able to answer any remaining questions;
3) Basic requirements of study:
    - blood sample obtained by medical professional,
    - urine and feces samples collected over weekend and returned Monday,
    - questions about health and diet must be answered;
4) Compensation of $25 would be provided to all who complete the study.

A more detailed accounting of the recruitment and sampling activities in each of the study areas is provided in Appendixes C and D for San Antonio and Marion County, respectively.

Administration of the Survey and Collection of Samples

Survey and sample collection activities were scheduled around a weekend to allow participants a convenient time for collection of 24-hour urine and fecal samples. Activities centered on a large meeting room in a school or community center, beginning on a Thursday or Friday and ending on the following Monday or Tuesday. One or two weeks before the scheduled meeting with recruits, announcements regarding the time and place of the sampling meeting were distributed to interested individuals. In general, the recruitment coordinator was responsible for contacting all recruits and for posting the meeting announcement in appropriate places.

The general sequence of survey activities was as follows. During the week preceding survey activities, sample kits and supporting materials were prepared. A truck or van was retained and loaded, and the materials were transported to the school or community center on Thursday or Friday. The meeting room was a large auditorium or gymnasium capable of handling the eight- to ten-member survey team and as many as 100 recruits. Volunteers were greeted by the recruitment coordinator and seated. Completed informed consent forms were collected and the volunteers were called forward one at a time to review the informed consent. The survey coordinator or his assistant reviewed the informed consent with each participant to determine if he understood the risks and commitments involved. The guidelines followed in reviewing the informed consent were as follows:

1) The consent form must have signatures of participant, responsible adult for those under 18 years of age, and witness.

2) The participant was asked the following questions:

   a) Have you read this form?

   b) Do you have any questions about the form?

   c) Do you understand that this is a health study and that we will need two stool samples, one urine sample, one blood sample, and information on your health and the foods you eat?

   d) Is this your signature?

   e) If minor: Is this your (father, mother, uncle, aunt, or other as indicated)'s signature?

3) Reviewer indicated on lower portion of form that the form was reviewed and the participant questioned to the satisfaction of the reviewer. Reviewer then signed and dated the form.

The participant card (Figure 4) was then initiated by recording the participant's name and address and indicating that a signed and proper informed consent was on record for the participant. The participant was then sent to the station with sampling kits, and the sampling coordinator assigned a kit to the participant. The computer-generated label in the sampling kit was then placed on the participant card. Because the computer label contained a unique participant number, this action effectively assigned a unique number to the participant. The contents of the sampling kit (as shown in Appendix B) were then explained and instructions for collection and storage of samples were reviewed with the participant. The printed instruction sheet included in the sample kit is presented in Appendix B.

The necessity of obtaining 24-hour samples for urine and feces was stressed in the instructions for sample collection. Nonetheless some of the samples obtained during the first scheduled sample collection period tended to be less than the volume normally collected in a 24-hour period. It was concluded that additional steps were required to effect collection of a more complete 24-hour sampling of all participants. The oral briefing on sample collection was restructured to emphasize the 24-hour nature of the specimens and a urine and stool sample log (shown in Figure 6) was provided for the participant to record the time and date of each addition to the urine sample container. As a result of this change of procedure, samples delivered during subsequent sampling periods were more uniformly representative of a 24-hour sample.

Upon receipt of the sampling kit and instructions, the participant was sent to the blood sampling station and blood was collected on the first day if the participant could spend the time required. This was done to make the study more efficient to the participant (he or she would then only have to deliver the samples on Monday and collect the $25 compensation) and also to establish even more strongly the participant's commitment to the study.

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URINE AND STOOL SAMPLE LOG

Please record the time and date each time you collect your urine sample. Remember, a true 24-hour sample is required. That is, collect urine every time you urinate from the time you get up one morning until the next morning.

	Time	Day	Date
Example:	8:30 a.m.	Saturday	July 18
URINE			

Also, remember your stool sample is needed on two days. Collect all of your bowel movement each time in the container. Do not put paper into the container. Please mark the log each day you collect the sample:

		Day	Date
STOOL	First Day ☐		
	Second Day ☐		

Participant Name

Signature

Figure 6. Urine and stool sample log

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Once blood samples were provided, most participants followed through with the remaining requirements. If it was inconvenient for the participant to give blood on the first day, he or she was told that the blood could be given on Monday when the urine and fecal samples were delivered. It was pointed out to the participant that blood samples were required for complete participation and this would necessitate presence of the participant at the study site on Monday. At all times the blood sampling activity was managed by the blood sampling coordinator, a member of the SwRI staff. Blood samples were collected by registered medical professionals via venipuncture. Participant and sample logs were maintained by the coordinator and the participant's card was initialed and stamped by the coordinator to indicate provision of a blood sample by the participant. In cases where one venipuncture did not yield a good sample, a second attempt was made at the discretion of the licensed medical professional and with the permission of the participant. When apparent difficulties were present due to bad veins, obesity, advanced age, or other similar problems, only one venipuncture was attempted and the participant was logged in as having successfully participated even though the blood sample was incomplete.

In collecting the health history information, the usual procedure was to interview the participant while waiting for one or another of the various stations to call him or her for processing. Chairs and tables were made available near the waiting areas, but far enough away to allow privacy of the information provided by the participant. The health history interviews were administered by members of the survey staff trained in the use of the health history form. The interviewer guide presented in Appendix E was issued to all survey interviewers and each interviewer was reviewed by the survey coordinator to determine his or her adequate understanding of the form and proficiency in administering the form through an interview. The survey staff who were trained and who served as interviewers include the survey coordinator, the assistant survey coordinator, and the recruitment coordinators.

After completion of the first day's activities, the participants were instructed to leave their participant card with the survey team and were allowed to leave with their sample kits. The participant card was kept so it would not be lost or misplaced by the participant and also so the survey team could estimate the degree of completion of the sampling activities.

After collection of samples over the weekend, the samples were delivered to the meeting area on Monday morning. The sample containers were taken out of the paper shopping bags, logged by the sample coordinator and the cooler and blue ice remained with the participant as a token gift of the study. Participants who had completed all other aspects of the study on Friday did not have to be present on Monday and were allowed to send their samples in with another participant, usually another member of their family. As the sample containers were removed from the shopping bags and placed in the storage container, an observation of the quantity of urine or fecal matter was made from the weight of the container. If the sample appeared to be short of an expected 24-hour sample, the participant was questioned. When deemed appropriate, the participant was asked to try again and deliver the sample the following day, if possible. Persons of advanced age indicating a problem with collecting two fecal samples in the allotted time were allowed to remain in the study with only one stool sample.

Blood samples and health history information were then collected on the remaining participants and a $25 check in partial compensation for their efforts and inconvenience was issued to each participant who provided a complete set of samples and the health history information.

The participant card proved to be extremely useful as a method of tracking participant status through the various stages of recruitment and sampling. Time and again the participants were told to "take this card to the next station." The card served as a passport and indicated completion status at all times. Participants retained their cards throughout the operations and meticulously returned the cards at the end of the first day's activities. The card was particularly useful for showing proof of completion of all tasks and was used in issuing the compensation check to the participant.

Preparation and Transport of Samples

The two 10-mL vacutainers of blood collected from each participant were refrigerated immediately after collection with wet ice and were maintained in this refrigerated condition during transport to the laboratory. Ice chests used for blood samples were dedicated to these samples and were not used to transport or store other materials or types of samples. The vacutainers used in the survey were pre-prepared with an anticoagulant so no preparation was required in the field.

The 24-hour urine sample was obtained from each participant in a 2-liter polyethylene jar, usually in a cool or cold refrigerated condition. The 2-liter jar was immediately placed in a large ice chest and kept in a refrigerated condition on wet ice during transport to the laboratory.

The two 24-hour fecal samples were obtained from each participant in the Sage Products specimen containers usually in a cool or cold refrigerated condition. The specimen containers were immediately placed in a large ice chest and kept in a refrigerated condition on wet ice until the end of day. At the end of the day, the specimen containers were transferred to a freezer, frozen, and maintained in frozen condition during transport to the laboratory on the following day. For samples obtained in San Antonio, the samples were transported to the laboratory on the same day they were received from participants and were maintained in a wet ice refrigerated condition during that brief transport.

A cargo-van was used in San Antonio to transport materials to the sampling site and to transport the samples to the laboratory. The

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relatively short distances involved (10 to 20 miles) and the multiple sampling periods in San Antonio presented a relatively simple sample transportation problem, easily handled with wet ice and a small van. Once the refrigerated samples were received at the laboratory, they were logged in and placed in a walk-in freezer until ready for analysis.

For the Marion County sampling site, transportation of the samples presented a significantly greater problem. A hi-cube van with 6 x 6 x 12 feet of cargo space was retained and used to transport materials from the laboratories in San Antonio to the sites in Marion County and to transport the samples from Marion County to the laboratories, a distance of approximately 400 miles. To facilitate handling of the samples, a chest-type freezer was installed in the hi-cube van and was connected to external electricity on site. The feces sample containers were removed from the temporary storage ice chests and placed in the freezer unit at the end of each sample collection activity. The freezer unit was operated overnight to completely freeze all contents before disconnection the following morning for the trip to San Antonio. The freezer unit was again connected to electricity that evening in San Antonio and the frozen samples were removed to the laboratory freezers the following morning. Urine samples maintained on wet ice during transport were also removed to the laboratory freezers the following morning.

Certificates of Appreciation

A letter and a certificate of appreciation suitable for framing were prepared and distributed to all participants who provided a complete set of samples to the study. The certificate was intended to convey the appreciation and gratitude of the survey staff for the efforts of the study participants. Copies of the letter and certificates distributed in San Antonio and Marion County are presented in Appendix F.

SAMPLE ANALYSIS

Clinical Chemistry Analysis

Instrumentation and Equipment--

A Bausch and Lomb Spectronic 700 Spectrophotometer was used for hemoglobin, serum-Fe, TIBC, and urine creatinine measurements. Blood hemoglobin determinations were performed with Stanbio CMH Sets (Stanbio Laboratories, San Antonio, Texas, Catalog Numbers 321 and 325). Serum-Fe and TIBC measurements were made with Stanbio Iron and TIBC Test Sets (Stanbio Laboratories, San Antonio, Texas, Catalog Number 0370).

Urine creatinine were measured with Stanbio CAP Creatinine Test Set (Stanbio Laboratories, San Antonio, Texas, Catalog Number 400). Urine specific gravities were measured with a urinometer (Model A-2745, Clay Adams, Parsippany, New Jersey). Urine concentrations of beta$_2$-microglobulin were determined with Phadebas beta$_2$ microradioimmunoassay kits (Pharmacia Diagnostics, Piscataway, New Jersey) with counting of the radioactive ^{125}I component on a Searle Gamma Counter, Model 1185.

Blood and Serum Analysis--

Hemoglobin--Hemoglobin was determined on whole blood samples by the spectrophotometric determination of the red-colored cyanmethemoglobin complex after the procedure of Drabkin (1946).

Serum-Fe and TIBC--The procedure used for serum-Fe and TIBC was a modification of that reported by Persijn (1971) using the chromogenic compound, ferrozine, described by Stookey (1970). Since Cu can also react with ferrozine to form a colored complex (Carter, 1971), neocuproine was used to prevent Cu interference.

Urine Analysis--

Specific gravity--Specific gravity was measured on freshly collected urine samples at room temperature using a urinometer.

Creatinine--Creatinine determinations were made on urine samples by a procedure using the Jaffe (1886) reaction between creatinine and an alkaline picrate solution which forms a red tautomer of creatinine picrate (Greenwald, 1928).

Beta$_2$-microglobulin--The Phadebas beta$_2$ microradioimmunoassay (Pharmacia Diagnostics, Piscataway, New Jersey) was used to detect the presence of beta$_2$-microglobulin in urine (Evrin et al., 1971). Urine specimens were diluted 1:10 (or greater) with Phadebas buffer containing Tween, and duplicate 100 µL samples were added to polystyrene centrifuge tubes. Beta$_2$-microglobulin ^{125}I (100 µL) was added to each tube. Sephadex anti-beta$_2$-microglobulin complex (100 µL) was added to each tube and the tube was incubated on a shaker for three hours at room temperature. The tubes were washed with 0.9 percent saline by centrifugation at 1200 x g for five minutes and counted in a Searle Gamma Counter with 70 percent efficiency for two minutes. Counts were expressed as a percentage of mean counts of the zero standard and the beta$_2$-microglobulin value in micrograms/24 hours was obtained from a lin-log standard curve prepared from dilution of purified beta$_2$-microglobulin. The urine samples for beta$_2$-microglobulin analyses were split, and duplicate analyses were performed for all samples. No control samples were utilized. The maintenance of urine samples at 4°C for 24 to 72 hours during initial storage and transport to the laboratory, followed by freezing and holding at -20°C until analysis, ensured the avoidance of any significant decomposition of beta$_2$-microglobulin.

Metal Analyses

Instrumentation--

All metal analyses were performed on either a 1) Perkin-Elmer Atomic Absorption Spectrophotometer, Model 5000 (with a HGA-500 graphite furnace and an AS-40 auto sampler for flameless analyses or an AS-3 auto sampler for flame analyses) or 2) Perkin-Elmer Atomic Absorption Spectrophotometer, Model 560 (with a HGA-500 graphite furnace and an AS-1 auto sampler).

Calibration curves and data evaluations were performed on a Hewlett-Packard Programmable Calculator, Model 9810-A, or a Texas Instrument Programmable Calculator, Model 59, with a PC-100A printer.

Reagents--

All chemical reagents were of analytical grade or better. Acids used for digestion, standards, and spiking were either redistilled (quartz still) or Suprapur grade.

Water was from a Millipore MilliQ water system (MilliR04).

Glassware and plasticware were acid-washed in 1:1 HNO_3 prior to use.

Whole Blood Analysis--

Cadmium (Cd) and lead (Pb) concentrations were determined in whole blood samples digested by the method of Perry, Koirtyohann and Perry (1975) with HNO_3 and H_2O_2.

A 1.0-mL aliquot of well mixed whole blood was transferred from the vacutainer collection tube to a 50-mL polyethylene digestion tube. Redistilled HNO_3 was added and the blood sample was heated (100°C) in a water bath until the sample was amber colored and no solids were evident. H_2O_2 (30%) was then added to complete the digestion procedure. The digestate was then filtered through a preacid-washed glass fiber filter (Reeve Angel 934AH). The filtrate was collected in a 10-mL volumetric flask and made to volume with MilliQ water.

An aliquot of this digested blood sample was further diluted with $NH_4H_2PO_4$ (5% solution), a matrix modifier, prior to Cd and Pb analyses by the graphite furnace AAS method of Hinderberger, Kaiser and Koirtyohann (1981) using a L'Vov platform. The graphite tube and platform were impregnated with Mo using the technique of Poldoski (1980). Lead determinations required another conditioning step of the platform with $La(NO_3)_3$ solution (5%) to remove matrix interferences (Poldoski, 1980). A 10-µL aliquot of the digestate containing the matrix modifier was injected into the graphite tube. Analyses for Cd and Pb were carried out with the instrument parameters given in Tables 5 and 6. The direct dilution (1+20) technique given in Gradwohl (1970) was used for blood-Fe determinations. Iron determinations were by flame AAS using the instrument parameters listed in Table 5.

Quality control samples for blood Cd, Pb and Fe analyses included spiked blood samples at three different concentration levels and NBS Standard Reference Material 1577, Bovine Liver. Blood samples were randomly assigned to "blocks" of 20 samples. The QC for each block consisted of one set of spiked (at three different levels) blood samples and one NBS Bovine Liver sample.

Urine Analysis--

Urine samples were digested by the method of Hinderberger, Kaiser, and Koirtyohann (1981) for Cd and Pb analysis.

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TABLE 5. INSTRUMENTAL PARAMETERS

Matrix	Metal	Wavelength nm	Slit nm	Type of analysis	Comments
Blood	Cd	228.8	0.7	Flameless	Matrix modifier, Mo-treated graphite tubes
	Pb	217.0	0.7	Flameless	Matrix modifier, Mo/La-treated graphite tubes
	Fe	248.6	0.2	Flame	Air-acetylene flame
Urine	Cd	228.8	0.7	Flameless	Mo-treated graphite tube
	Pb	217.0	0.7	Flameless	Mo/La-treated graphite tube
Feces	Cd	228.8	0.7	Flameless	Mo-treated graphite tube
	Pb	217.0	0.7	Flameless	Mo/La-treated graphite tube
	Fe	248.6	0.2	Flame	Air-acetylene flame
	Zn	213.9	0.7	Flame	Air-acetylene flame
	Ca	422.4	2.0	Flame	Nitrous oxide-acetylene flame

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TABLE 6. FLAMELESS ANALYSES PROGRAMS

			Program												
			Step 1		Step 2		Step 3		Step 4		Step 5		Step 6			
Matrix	Metal	Type of tube	Time, sec.	Temp, °C	Time, sec.	Temp, °C	Time, sec.	Temp, °C	Time, sec.	Temp, °C	Time, sec.	Temp, °C	Time, sec.	Temp, °C	Atomization gas flow mL/min	Comments
Blood	Cd	pyrocoated	40	100	35	750	3	2100	7	20	5	2700	7	20	10	L'Vov platform technique with Mo-modified tubes
	Pb	pyrocoated	40	100	35	350	3	2100	7	20	5	2700	7	20	20	L'Vov platform technique with Mo/La-modified tubes
Urine	Cd	pyrocoated	40	100	35	750	3	2100	7	20	5	2700	7	20	10	L'Vov platform technique with Mo-modified tubes
	Pb	pyrocoated	40	100	35	350	3	2100	7	20	5	2700	7	20	20	L'Vov platform technique with Mo/La-modified tubes
Feces	Cd	uncoated	35	100	35	250	3	2100	7	20	--	--	--	--	--	Calibration by "method of addition"
	Pb	uncoated	35	100	35	600	3	2300	7	20	--	--	--	--	--	Calibration by "method of addition"

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A 10-mL aliquot of well mixed urine was transferred to a 30-mL Kjeldahl flask and digested with 5 mL of redistilled HNO_3 at 100°C. The digestate was diluted to its original volume (10 mL) with MilliQ water and analyzed for Cd and Pb by the graphite furnace AAS method described earlier for blood (Hinderberger, Kaiser, and Koirtyohann, 1981).

A 10-µL aliquot of the digestate plus the matrix modifier, $HN_4H_2PO_4$ (see blood analysis) was injected into the graphite tube. Cadmium and lead analyses were performed using the instrumental parameters listed in Tables 5 and 6.

Since no reference standards for urine exist, the quality control samples consisted of a spiked (at three different concentrations) urine sample for every 20 samples analyzed. Recovery of these spiked samples ranged from 89% to 108% for Cd and 94% to 103% for Pb.

Feces Analysis--

Feces samples were digested with the HNO_3 and H_2O following the recommendations of Bock (1979) for organic matrices.

Feces samples were thawed and homogenized with a motorized Teflon-Ball homogenizer. An aliquot (5 to 10 g) of this homogenized feces was transferred to polyethylene cups, frozen, then freeze-dried (Labconco Model 12). The freeze-dried material was further homogenized with a Virtis 45 homogenizer before removing 1.0 g for digestion.

The 1.0 g of freeze-dried feces was weighed into a 250-mL Teflon beaker and 20 mL of redistilled HNO_3 was added. The sample was digested on a hot plate (100°C) until the resulting solution was a clear amber color. Then 5 mL of H_2O_2 (30%) was added to complete the digestion. The digestate was then filtered through a preacid-washed glass-fiber filter (Reeves Angel 934AH) and the filtrate was diluted to 10 mL with MilliQ water.

This solution was analyzed for Fe, Zn, and Ca by flame AAS using the parameters listed in Table 5; Cd and Pb analyses were by graphite furnace AAS using the parameters in Table 6.

Quality control samples for feces were one NBS Standard Reference Material 1577, Bovine Liver, plus one feces sample spiked at three different concentration levels for every 16 to 20 feces samples.

Sample quantitation was by the "method of addition" for all metals analyzed.

DATA ANALYSIS

Data handling methods fell into three general categories:

1) estimation of central tendencies;
2) investigation of effects of smoking;

3) investigation of correlation between Cd levels and other measurements.

The data handling procedures for these investigations are discussed in the following sections.

Estimation of Central Tendency

For each study parameter, the central tendency was estimated by calculating mean values for each of the eight separate subgroups (two ethnic groups x two age groups x two sexes). In order to achieve homogeneity of variance between groups and to minimize the effects of the scattering of extreme values, a geometric mean was calculated for the majority of the study variables. The exceptions were blood-Fe, hemoglobin and TIBC where no transformation was required. The natural logarithm of each result was taken, a mean calculated, and that mean exponentiated to give the geometric mean in the original scale units. Where there was a predominance of values between 0 and 1 in the data, as in the Cd concentrations, a transformation of ln(x+a) (Snedecor and Cochran, 1973) with a=1 was used in order to smooth the data set.

The concentrations of Cd and Pb in urine was adjusted for specific gravity as recommended by Elkins (1974). According to this, all concentrations were adjusted to a common value of 1.024 as follows

$$[\mathrm{Cd}]_{\mathrm{adjusted}} = \frac{1.024 - 1}{\text{specific gravity} - 1}\,[\mathrm{Cd}]_{\mathrm{raw}} \quad .$$

Mean values were determined for both the adjusted and unadjusted data sets, but the adjusted values were used in all correlations.

Total elimination of the study metals through feces was estimated for each population subgroup and total ingestion was estimated for Cd and Pb. The weights of the feces samples were not used since they were in many cases not representative of true 24-hour samples. The concentration of the metal in the feces was multiplied instead by a constant factor (daily weight) for each age group obtained from Kowal et al. (1979). The assumed weights were 125 grams for young males, 98 for young females, 105.5 for older males, and 79.5 for older females. The Cd and Pb values were then corrected for absorption, assuming 4.6% absorption for Cd and 9% for Pb (Kowal et al., 1979; National Research Council, 1980).

Investigation of Effects of Smoking

To determine whether cigarette smoking could be related to increased Cd levels in blood and urine, the data were subjected to an analysis of variance (ANOVA) procedure. The subjects from each area were divided into three groups without regard to age: current smokers, current nonsmokers, and nonsmokers. The current nonsmokers consisted of those who indicated

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that they had previously smoked but were not smoking at the time of the survey. The rationale behind this is that previous smoking habits can result in elevated body burdens of Cd that can be detected in the urine (Johnson et al., 1978b) beyond the end of actual cigarette use by the individual.

The ANOVA's were calculated using a one-way model of

$$Y = \mu + \gamma_i + \varepsilon_{ij} \quad ,$$

where μ - overall mean

γ_i - group effect, i = 1, 2, 3

ε_{ij} - random error associated with individual j in group i.

Where the ANOVA resulted in a significant result, a means separation was used to determine which means could be considered to be significantly different from each other. For two means to be different they must exceed the least significant difference (LSD) calculated as

$$LSD_{0.05} = \sqrt{2} \quad \sqrt{MS_E \left(\frac{1}{n_i} + \frac{1}{n_j}\right)}$$

where MS_E is the mean square for error from the ANOVA table and n_i and n_j are the numbers of individuals in the two groups under comparison.

Investigation of Correlation with Cd Levels

The level of beta$_2$-microglobulin in the urine can be one indicator of disease resulting from a high body burden of Cd. Similarly, serum-Fe and hemoglubin, which would indicate iron deficiency, could be inversely related to the body burden of Cd. As a result, it was considered to be of interest to determine if these other measurements tracked the Cd concentration in the urine, since urine is the best indicator of body burden.

To determine if there was any relationship, correlation analyses were performed and the significance determined. The correlation analyses were performed using the transformed data where appropriate.

The possible influence of Ca and Zn levels on absorption rates of Cd was a stated interest of this study and analysis of the data regarding possible Cd/Ca/Zn relationships was considered in the study plan. However, consistently low levels of Cd in blood and urine prevented any meaningful analysis of potential Ca or Zn effects.

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SECTION 5

RESULTS

THE STUDY POPULATIONS

Characteristics of the two study populations are presented in this section. As discussed previously, all participants of hispanic heritage or language resided in San Antonio and all rural black participants resided in Marion County. The goal of the study was to have a total of 240 participants with equal numbers in each of eight population subgroupings:

		Number of participants	
Age group	Sex	Urban hispanic	Rural black
12-18	Male	30	30
	Female	30	30
50+	Male	30	30
	Female	30	30

The age distributions of the sampled study populations are presented in Table 7. The design goal of 30 or more qualified participants in each of the eight population groupings was exceeded in all groupings except the hispanic females, 12 to 18 years, where a total of 29 participants were sampled. However, the combination of male and female hispanic participants in the 12 to 18 years category exceeded the design goal of 60 participants. All participants enumerated in Table 7 met the respective ethnic or racial requirement, and no obviously pregnant females were included.

Smoking history of the participants is described in Table 8. Some 25 percent of the adult participants indicated they are currently smoking. This compares to an estimate of 36% for the adult U.S. population reported at the Second World Conference on Smoking and Health (Richardson, 1971). As expected, adult males indicated the highest rates with 56 percent reporting either a current or past smoking history. Only 16 percent of the younger age group indicated current or past smoking. An anomaly was noticed in the data for younger black males in Marion County. The general pattern of males reporting greater smoking history than females (in the other population subgroups in this study and in the general population) did not hold true for this group. The younger males reported less smoking by a factor of 5. The possibility of underreporting in this group should be considered. Parental presence at or near the place of interview could have

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TABLE 7. AGE DISTRIBUTION OF STUDY POPULATION

Participant group	Age group	Sex	Average age	Number of participants
Urban hispanic	12-18	Male	15.9	40
		Female	16.6	29
	50+	Male	62.5	32
		Female	59.6	31
Rural black	12-18	Male	14.6	36
		Female	15.2	39
	50+	Male	64.0	31
		Female	64.7	31
TOTAL				269

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TABLE 8. SMOKING HISTORY

Participant group	Age group	Sex	Number of participants			Percent ever smoked
			Smokers	Past smokers	Nonsmokers	
Urban hispanic	12-18	Male	10	2	28	30
		Female	3	2	24	17
	50+	Male	10	9	11	63
		Female	10	5	16	48
Rural black	12-18	Male	1	0	35	3
		Female	5	0	33	15
	50+	Male	9	7	15	52
		Female	2	2	27	13
TOTAL			50	27	189	29

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suppressed this information. In San Antonio, the majority of the younger hispanic group were interviewed at school, away from the presence of parents.

As indicated by annual family income data on the participants presented in Table 9, the study population was of low income. Income data were requested from all participants but were not required if the participant objected to providing it to the interviewer. Ninety-three percent of the participants did provide the income information with only 20 of the 168 families not reporting income data. Of those families reporting, 46 percent of the urban hispanics and 57 percent of the rural blacks indicated a family income of $5,000 per year or less during the most recent year (1979). The poverty thresholds established by the U.S. Census Bureau for use in the 1980 census of the population are $5,787 for a family of three, $7,412 for a family of four, and $8,776 for a family of five. More than 81 percent of the study families reported an income of $10,000 or less. This compares to a median annual family in the U.S. during 1979 of $21,010.

The reported frequency of consumption of selected foods is presented for each of the four major study population subsets (two age groups, two ethnic groups) in Tables 10 through 13. Data are presented for four consumption frequencies: never, less than weekly, weekly, and daily. Summary statistics for the percent of each population reporting consumption of the selected food type once or more per week are presented in Table 14. The weekly consumption patterns for the study populations shows a consistent and high (90 percent or more) frequency of consumption of potatoes, leafy vegetables, corn and corn products, and other grains and cereals known (Pahren et al., 1979; Naylor and Loehr, 1981) to contain high (20 to 40 ppb) levels of cadmium. However, similar high frequency of consumption is indicated for foods which contain lower (3 to 15 ppb) levels of cadmium: milk and dairy products, fruit, and meat and poultry. Survey questions regarding special diets and home gardens did not produce significant results and are not discussed further.

The relative frequency of diseases and illnesses reported by the study population is presented in Table 15. It must be noted that treatment of the disease by a physician was required in this self-reporting by the participant. From the data, it is seen that high blood pressure was reported most frequently with 32 percent of the adults reporting this disease. Heart disease was the second most frequently reported disease with 18 percent of the adults reporting this disease. For both of these diseases, the reported prevalence among adult females was higher in the rural blacks by a large factor (factor of 2 for blood pressure; factor of 10 for heart disease). Kidney disease was reported by approximately 10 percent of the black adults. This was a factor of 3 greater than that reported by adults in the hispanic population.

TABLE 9. ANNUAL FAMILY INCOME DATA

Participant group	Age group	Sex	Annual family income before taxes (thousands) 0-5	5-10	10-15	15-20	>20	Unknown
Urban hispanic	12-18	Male	12	16	5	2	1	4
		Female	8	9	7	2	2	1
	50+	Male	19	9	3	1	0	0
		Female	20	10	1	0	0	0
	Subtotal		59	44	16	5	3	5
Percent of those reported			46	35	13	4	2	-
Cumulative percent reported			46	81	94	98	100	-
Rural black	12-18	Male	16	12	0	1	1	6
		Female	16	12	0	2	3	6
	50+	Male	15	10	2	0	1	3
		Female	22	7	0	0	0	0
	Subtotal		69	41	2	3	5	15
Percent of those reported			57	34	2	3	4	-
Cumulative percent reported			57	91	93	96	100	-

TABLE 10. FREQUENCY OF CONSUMPTION OF SELECTED FOODS: URBAN HISPANIC POPULATION 12 TO 18 YEARS OF AGE

Type of food	Percent of population reporting specified frequency: Never	Less than weekly	Weekly	Daily
Shellfish	43	39	18	0
Organ meats	37	41	21	1
Potatoes	0	1	74	25
Leafy vegetables	9	4	57	30
Root vegetables	21	27	36	16
Corn and corn products	0	7	55	38
Other grains and cereals	1	1	32	66
Milk and dairy products	0	1	34	65
Fruit	1	6	41	52
Meat and poultry	0	3	46	51
Fish	3	24	70	3

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TABLE 11. FREQUENCY OF CONSUMPTION OF SELECTED FOODS: URBAN HISPANIC POPULATION 50 OR MORE YEARS OF AGE

Type of food	Percent of population reporting specified frequency			
	Never	Less than weekly	Weekly	Daily
Shellfish	27	29	44	0
Organ meats	19	25	54	2
Potatoes	0	5	78	17
Leafy vegetables	3	2	68	27
Root vegetables	11	8	70	11
Corn and corn products	5	2	57	36
Other grains and cereals	5	3	53	39
Milk and dairy products	2	2	48	48
Fruit	2	2	72	24
Meat and poultry	0	0	66	34
Fish	10	15	75	0

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TABLE 12. FREQUENCY OF CONSUMPTION OF SELECTED FOODS: RURAL BLACK POPULATION 12 TO 18 YEARS OF AGE

Type of food	Percent of population reporting specified frequency			
	Never	Less than weekly	Weekly	Daily
Shellfish	51	42	6	1
Organ meats	57	22	21	0
Potatoes	0	10	78	12
Leafy vegetables	7	12	55	26
Root vegetables	21	26	46	7
Corn and corn products	1	7	53	39
Other grains and cereals	0	1	14	85
Milk and dairy products	3	3	20	74
Fruit	0	10	43	47
Meat and poultry	0	1	10	89
Fish	7	20	69	4

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TABLE 13. FREQUENCY OF CONSUMPTION OF SELECTED FOODS: RURAL BLACK POPULATION 50 OR MORE YEARS OF AGE

Type of food	Percent of population reporting specified frequency Never	Less than weekly	Weekly	Daily
Shellfish	48	37	15	0
Organ meats	16	61	23	0
Potatoes	2	10	85	3
Leafy vegetables	2	5	67	26
Root vegetables	5	13	77	5
Corn and corn products	5	2	58	35
Other grains and cereals	3	5	13	79
Milk and dairy products	0	7	37	56
Fruit	2	10	55	33
Meat and poultry	0	0	27	73
Fish	3	23	71	3

TABLE 14. FREQUENCY OF CONSUMPTION OF SELECTED FOODS: SUMMARY STATISTICS FOR STUDY POPULATIONS

	Percent of study population reporting consumption once or more per week			
	Urban hispanic		Rural black	
Type of food	12-18 years	50+ years	12-18 years	50+ years
Shellfish	18	44	7	15
Organ meats	22	56	21	23
Potatoes	99	95	90	88
Leafy vegetables	87	95	81	93
Root vegetables	52	81	53	82
Corn and corn products	93	93	92	93
Other grains and cereals	98	92	99	92
Milk and dairy products	99	96	94	93
Fruit	93	96	90	88
Meat and poultry	97	100	99	100
Fish	73	75	73	74

TABLE 15. RELATIVE FREQUENCY OF DISEASES/ILLNESSES

Participant group	Age group	Sex	Kidney disease	Liver disease	Heart disease	High blood pressure	Cancer	Anemia	Bone disease
Urban hispanic	12-18	Male	0.026	0.051	0.026	0	0	0.026	0
		Female	0.036	0	0.036	0.107	0	0.143	0.036
	50+	Male	0.031	0	0.219	0.281	0	0	0.031
		Female	0.031	0	0.031	0.250	0.031	0.031	0.125
Rural black	12-18	Male	0	0	0.026	0.026	0	0	0
		Female	0.026	0	0	0.026	0	0	0
	50+	Male	0.097	0.032	0.161	0.194	0.032	0.032	0
		Female	0.097	0	0.323	0.548	0.032	0.065	0.065

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CHEMICAL ANALYSES

Clinical Chemistry Analysis

Concentration means and ranges for the results of clinical chemical analysis are presented in Table 16. These data are presented separately for each of the two study populations for each of the following parameters: hemoglobin, serum iron, TIBC, specific gravity and volume of urine, urine creatinine, urine beta$_2$-microglobulin, and weight of feces. Data for serum iron and TIBC for the rural black population group are missing from these data because the blood samples hemolyzed during storage. The samples were spun down and stored for a period of time before analysis. Procedures for performing analysis for these two parameters were not successful with the hemolyzed samples.

For the parameters listed in Table 16, the results of clinical chemical analysis are presented for each of the study participants and are presented in Appendix G. Multiple results are presented where more than one sample or split samples were analzyed separately. Participant identification number, sex, and age are specified for each set of data. The two study populations can be identified in these data from the series of participant identification numbers assigned to the two groups. Participant identification numbers for the urban hispanic population are 01-144; for the rural black population, the identification numbers are 201-340.

Trace Metal Analysis

Concentration means and ranges for the results of trace metals analysis are presented in Table 17. These data are presented separately for each of the two study populations for each of the following parameters: blood cadmium, lead, and iron; urine cadmium and lead; and feces calcium, cadmium, iron, lead, and zinc. The detailed results of trace metals analysis for each of the study participants are presented in Appendix G. Where analysis was performed on more than one sample, or on separate split samples, each of the results is presented separately.

Accuracy and Precision

Table 18 contains the accuracy and precision data, respectively, of the methodologies used for blood, urine, and feces for all analyte metals. Accuracy data in Table 19 are from NBS Bovine Liver samples or from spiked samples. Data in Table 18 for precision are from repeated analyses of actual sample aliquots.

Detection Limits--

Table 20 gives the analyte detection limits of the different methodologies (blood, urine, and feces).

TABLE 16. CONCENTRATION MEANS AND RANGES FOR CLINICAL CHEMISTRY ANALYSIS SAMPLES

Parameter	Units	Urban Hispanics		Rural Blacks	
		Range	Mean	Range	Mean
Hemoglobin	g/dL	9.7-19.2	14.8	8.8-17.9	13.6
Serum-Fe	μg/dL	4.0-446	123.3	-----*	
TIBC	μg/dL	182-539	350.2	-----*	
Urine					
specific gravity		1.001-1.039	1.020	1.004-1.037	1.018
volume	L	0.0739-1.848	0.8053	0.2715-1.9358	1.1813
creatinine	mg/dL	14.1-322	130.4	7.4-34.6	88.6
beta$_2$-microglobulin	μg/L	3.0-2530	141.5	3.0-780	77.0
Feces Weights	g	1.05-386	79.0	3.24-451	91.8

*No data obtained.

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TABLE 17. CONCENTRATION MEANS AND RANGES OF TRACE METALS SAMPLES

Matrix/Metal	Units	Urban hispanics		Rural blacks	
		Range	Mean	Range	Mean
Whole blood					
Cd	µg/dL	<0.036-2.484	0.131	<0.036-2.898	0.083
Pb	µg/dL	<0.78-51.6	6.11	1.05-41.3	8.98
Fe	µg/dL	29.2-60.2	46.8	30.6-57.0	46.3
Urine					
Cd	µg/L	0.12-230	0.652	<0.12-170	0.480
Pb	µg/L	<0.74-33	3.06	<0.74-93	6.26
Feces					
Ca	mg/g	1.74-57.4	4.54	3.18-74.53	4.77
Cd	µg/g	0.065-2.63	0.091	0.004-1.970	0.105
Fe	µg/g	3.09-1860	65.0	2-2842	66.8
Pb	µg/g	0.02-10.3	0.289	<0.04-366	0.435
Zn	µg/g	40-1495	74.9	98-1326	94.1

TABLE 18. PRECISION OF METAL ANALYSES PROCEDURES

Metal	Parameter	Blood* µg/dL	Urine** µg/L	Feces*** µg/g
Cd	$\bar{x}$	0.278	1.32	0.230
	σ	0.018	0.09	0.007
	CV (%)	6.4	6.8	3.0
	n	4	4	5
Pb	$\bar{x}$	2.36	22.8	0.28
	σ	0.003	1.0	0.02
	CV (%)	10.6	4.3	7.1
	n	6	7	5
Fe	$\bar{x}$	20480	ND	265
	σ	1458	ND	22
	CV (%)	7.1	ND	8.3
	n	6	ND	5
Zn	$\bar{x}$	ND	ND	122
	σ	ND	ND	4
	CV (%)	ND	ND	3.3
	n	ND	ND	5
Ca	$\bar{x}$	ND	ND	124
	σ	ND	ND	5
	CV (%)	ND	ND	4.0
	n	ND	ND	5

* Based on procedure using 1 mL of whole blood.
** Based on procedure using 10 mL of urine.
*** Based on procedure using 1 g (dry wt) of feces.

TABLE 19. MEAN RECOVERY OF TRACE METALS FROM NBS BOVINE LIVER SAMPLES AND RANGE (%) OF RECOVERIES FROM SPIKED URINE SAMPLES USED AS QUALITY CONTROL SAMPLES.

	Cd µg/g	Ca µg/g	Fe µg/g	Pb µg/g	Zn µg/g
Bovine Liver*					
Reported	0.27	124	268	0.34	130
Measured	0.25	123	232	0.28	124
% Recovery n=12	94	99	87	83	95
	µg/L			µg/L	
Spiked Urine**					
Spike level	1.0	ND	ND	20.0	ND
% Recovery range n=12	89-108			94-103	

* Used as QC for blood and feces digestion.
** Used as QC for urine digestion.
ND = not determined.

TABLE 20. DETECTION LIMITS* OF METAL ANALYSES

Metal	Blood µg/dL	Urine µg/L	Feces µg/g (dry wt)
Cd	0.072	0.12	0.002
Pb	0.78	0.74	0.033
Fe	2400	--	4.3
Zn	--	--	3.5
Ca	--	--	43

* Detection limit of methodology (instrument detection limit: S/N ratio of 2).

DATA ANALYSIS

Central Tendency

The data were used as indicated in Section 4 to calculate mean results for each subgroup under study. These results are shown in Table 21 for mean concentrations of selected metals and other parameters. For comparison purposes, the mean Cd and Pb concentrations in the urine were expressed both adjusted for a specific gravity of 1.024 and unadjusted.

As expected, higher concentrations of Cd were found in the urine of the older age groups than in the younger age groups in each of the studied populations. This occurs because of the tendency to accumulate Cd over time and because urine is an indicator of body burden of metals. The 10-19 age groups have higher concentrations of Cd in their feces than the 50 and over group, but this merely reflects the current consumption of Cd and not body burden.

Table 22 reflects the calculated daily elimination values for the five study metals. These reflect the differences in the groups not only in the concentrations of the metals, but also in the relative amounts of daily elimination for the different age and sex groupings. In Table 23, the mean eliminations for Cd and Pb were corrected for absorption and are presented to represent the amount of these metals ingested in the diets of the study subgroups.

Effects of Smoking

The effects of smoking were investigated by conducting analyses of variance on the transformed data, as described in Section 4. The ANOVA tables generated as a result of these investigations are shown in Appendix H.

The principal effect noticed was in the concentration of Cd in the urine for both the urban hispanic and rural black groups. Among the urban hispanics both current smokers and current nonsmokers exhibited significantly higher concentrations of Cd in their urine, with mean values of 2.254 and 2.096 µg/L, respectively, compared with a mean of 0.099 µg/L for the nonsmokers. The equivalence of current smokers and former smokers is consistent with the findings of the Dallas study and is not unexpected due to the buildup of Cd that can occur with smoking and the relatively slow elimination that takes place. Among the rural blacks, the current smokers were significantly higher than both nonsmokers and current nonsmokers, with a mean value of 0.954 µg/L compared to means of 0.553 µg/L for both of the other groups. No indication of an increase in Pb concentration in urine was noticeable in either group.

ANOVA's on the blood data resulted in only one significant result. Among rural blacks, there was a significant difference concentration of Pb in blood. Using the means separation technique discussed in the methods

TABLE 21. MEAN CONCENTRATIONS OF SELECTED METALS AND OTHER PARAMETERS IN FECES, URINE, AND BLOOD

Biological medium	Parameter	Units	Population group							
			Urban hispanic				Rural black			
			12-18 years		>50 years		12-18 years		>50 years	
			Male	Female	Male	Female	Male	Female	Male	Female
Feces (wet weight)	Cd	μg/g	0.116	0.105	0.072	0.067	0.128	0.107	0.097	0.084
	Pb	μg/g	0.395	0.306	0.257	0.187	0.293	0.373	0.708	0.460
	Zn	μg/g	87.5	112	51.5	61.8	107	91.4	84.9	92.2
	Ca	mg/g	5.29	6.79	3.13	3.76	4.82	5.03	4.23	5.07
	Fe	μg/g	87.5	82.7	42.2	56.8	65.4	67.8	74.4	61.3
Urine (adjusted to specific gravity)	Cd	μg/L	0.534	0.416	0.983	0.759	0.355	0.371	0.517	0.734
	Pb	μg/L	3.0	3.1	4.9	1.9	6.3	5.7	8.5	5.4
Urine (unadjusted)	Cd	μg/L	0.462	0.352	0.629	0.498	0.284	0.247	0.341	0.466
	Pb	μg/L	2.59	2.69	3.12	1.22	5.04	3.89	5.58	3.68
	$beta_2$*	μg/L	93.2	39.9	101	132	38.6	26.2	27.7	28.8
	creatinine	mg/dL	155	124	78.4	83.5	86.6	67.9	73.7	52.5
Whole blood	Cd	μg/dL	0.176	0.116	0.108	0.118	0.062	0.063	0.116	0.105
	Pb	μg/dL	7.28	3.92	9.26	4.95	9.03	6.80	13.88	8.60
	Fe	mg/dL	48.74	44.59	48.66	44.94	47.42	43.65	49.89	45.57
	hemoglobin	g/dL	15.50	13.70	15.28	14.35	13.95	12.72	14.98	13.29
Blood serum	Fe	μg/dL	142	85.4	104	108	**	**	**	**
	TIBC*	μg/dL	363	370	321	344	**	**	**	**

* $beta_2$ - $beta_2$-microblobulin
TIBC - total iron binding capacity

** Data unavailable

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TABLE 22. MEAN DAILY ELIMINATION LEVELS OF CADMIUM, LEAD, ZINC, CALCIUM, AND IRON AS DETERMINED FROM FECAL ANALYSIS

		Population group							
		Urban hispanic				Rural black			
		12-18 years		>50 years		12-18 years		>50 years	
Element	Units	Male	Female	Male	Female	Male	Female	Male	Female
Cd	µg/day	14.6	10.3	7.5	5.3	16.0	10.5	10.3	6.7
Pb	µg/day	49.4	30.0	27.1	14.9	36.8	36.3	74.7	35.5
Zn	mg/day	10.9	10.9	5.43	4.92	13.4	8.96	8.96	7.33
Ca	mg/day	661	665	330	299	602	493	446	403
Fe	mg/day	10.9	8.10	4.46	4.52	8.18	6.65	7.85	4.87

TABLE 23. MEAN ESTIMATED DAILY INGESTION OF CADMIUM AND LEAD AS DETERMINED FROM FECAL ANALYSIS ADJUSTED FOR ABSORPTION

		Population group							
		Urban hispanic				Rural black			
		12-18 years		≥50 years		12-18 years		≥50 years	
Element	Units	Male	Female	Male	Female	Male	Female	Male	Female
Cd*	µg/day	15.3	10.8	7.9	5.6	16.8	11.0	10.8	7.0
Pb**	µg/day	54.3	33.0	29.8	16.4	40.2	40.2	82.1	40.2

* Fecal cadmium levels were adjusted upward to account for estimated absorption rate of 4.6%; Kowal et al., 1979.

** Fecal lead levels were adjusted upward to account for estimated absorption rate of 9.0% (average for adults ranges 8 to 10%); National Academy of Sciences, 1980.

section, the current smokers have significantly higher concentrations of Pb in their blood than the nonsmokers. The means could not be completely separated from one another, so that the mean concentration for the current nonsmokers was statistically indistinguishable from either of the other mean values. The concentrations were 5.31, 6.69, and 8.17 µg/L for the nonsmokers, current nonsmokers, and current smokers, respectively.

Correlation with Cd Body Burden

The correlation analysis performed to investigate the relationship between body burden of Cd and other measurements is summarized in Table 24.

TABLE 24. CORRELATION COEFFICIENTS OF CANDIDATE CD BODY BURDEN INDICATORS

	Urine Cd versus		
	Serum-Fe	Hemoglobin	Beta$_2$-microglobulin
Urban Hispanic	0.099	0.152	0.063
Rural Black	--*	0.122	0.126

* Serum Fe data not obtained.

None of the calculated coefficients is more than marginally significant at the 0.05 level. Furthermore, the square of the correlation coefficient estimates the percentage of the total variability that is explainable by the relationship between the two measurements. For these data, the largest r^2 is 0.023, or an explained variation of 2.3 percent of the total. On this basis, the use of any of these candidates as an indicator of body burden does not appear to be viable.

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SECTION 6

DISCUSSION

This study was designed to survey the ingestion of cadmium and lead in selected high risk populations in the United States and to examine body burdens and health effects associated with these metals. The study focused on nonoccupational exposures through normal food and drink ingestion and through smoking. Previous studies have shown that the general population in the U.S. without specific occupational exposures exhibit little evidence of cadmium intoxication. In the general population, cadmium has been found in tissues at levels below amounts considered detrimental to health. It tends to concentrate in organ tissues, particularly the kidneys, and the concentration level increases with increasing age.

Cadmium levels found in the general U.S. population are considered to be within safe bounds to avoid deleterious health effects but close enough to warrant concern about individuals with higher than normal exposures. Kidney cortex levels of 30 μg/g are common in older persons and damage to renal tubules is known to occur when levels exceed 200 μg/g (Naylor and Loehr, 1981). The two populations selected for this study were thought to be at potentially higher risk than the general U.S. population because low income and ethnic food preferences may combine to produce a tendency for consumption of foods with higher cadmium content and socioeconomic circumstances could possibly yield higher than normal cadmium absorption rates due to iron deficiency or levels of calcium or zinc consumption. This study was intended to determine whether this concern is founded in fact. To address these issues, the study results have been examined and are discussed as follows.

THE STUDY POPULATION

The two study populations participating in this survey were clearly of the income, ethnic/racial, and urban/rural characteristics for which the study was designed: low income urban hispanics of Mexican-American heritage and low income rural blacks. Roughly half of the families (46 percent of the hispanic families and 57 percent of the black families) indicated annual incomes of $5,000 or less. This level is below the poverty threshold established by the U.S. Census Bureau for a family of three or more and compares to a median annual family income of $21,020 in the U.S. during that same year. The study sites were notably urban and rural (San Antonio and Marion County, respectively), and the study populations selected within these sites were specifically black or hispanic

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language, i.e., only persons identified as black or hispanic were selected for the study.

PATTERNS OF FOOD CONSUMPTION AND DISEASE STATUS

Each of the two study populations reported relatively high frequency of consumption of potatoes, leafy vegetables, corn and corn products, and other grains and cereals known to contain higher levels of cadmium; 90 percent or more of the reporting individuals in each of the two study populations indicated consumption of these foodstuffs at least once per week. However, a similar high frequency was reported for foods with lower levels of cadmium: milk and dairy products, fruit, meat, and poultry. The food consumption patterns do not appear to be oriented to the higher cadmium foods.

The frequency of diseases and illnesses reported by the two study populations shows a high frequency of blood pressure and heart disease among both the populations but particularly high among the older black females; 32 percent reported heart disease and 55 percent reported high blood pressure. The reported prevalence of kidney disease among the older blacks, both male and female, was high; ten percent of the older blacks reported kidney disease as compared to less than four percent for the older hispanics. Differences in reported food consumption patterns for the older black group do not account for these higher reported heart, blood, and kidney disease prevalences nor do the data for ingestion of cadmium and lead as determined from fecal analysis. Mean beta$_2$-microglobulin levels for the older blacks are on the low side of the normal range [mean of 28 μg/L measured versus a reported mean of 71 μg/L for females and 89 μg/L for males in the general population (Kowal and Kraemer, 1981)]. Elevated beta$_2$ (greater than 400 μg/L) was found in only three of the total black population. No correlations are drawn between the reported incidence of disease and the reported consumption frequencies or biochemical measurements.

MEASURED LEVELS OF METALS AND HEALTH INDICATORS

Study results regarding measured levels of cadmium, lead, calcium, zinc, iron, iron binding capacity, hemoglobin, and beta$_2$-microglobulin presented in Section 5, Tables 21 through 23 are compared to values reported for the general population and discussed separately for each of the two study populations. Reference values reported in the literature used in these comparisons are presented in Table 25.

Urban Hispanics

The mean values of cadmium found in feces ranged 7.5 to 14.6 μg/day for males and 5.3 to 10.3 μg/day for females; mean values for lead in feces ranged 27 to 49 μg/day for males and 15 to 30 μg/day for females. These levels are lower than levels reported previously for the general population. The lower values for females than for males for these metals

TABLE 25. REFERENCE VALUES REPORTED IN THE LITERATURE FOR NONOCCUPATIONALLY EXPOSED INDIVIDUALS

Biological medium	Parameter measured	Units	Health Implications of Sewage Treatment Facilities[a] Age 7-18 Male	Age 7-18 Female	Age 46+ Male	Age 46+ Female	Development of Analytical Techniques to Measure Human Exposure to Fuel Additives[b] Combined controls	Normal Levels of Cd in Diet, Urine, Blood, and Tissues of Inhabitants of United States[c] Age 10-19	Age 50-59	Distribution of Cadmium and Other Metals in Human Tissues[d] Age 10-19	Age 50+	Others
Feces	Cd	µg/day	19.3	16.7	14.2	10.1	23.6-28.3	18.39-23.59	0.6-20.3	6.1-24.2	mean 11.4	--
	Pb	µg/day	155.0	91.1	74.3	67.0	260-319	ND	ND	ND	ND	141.6±9.4[e]
	Zn	mg/day	13.78	9.14	8.61	8.49	ND	ND	ND	ND	ND	4.0-10.1[f]
	Ca	mg/day	ND	ND	ND	ND	ND	ND	ND	ND	ND	350-700[f]
	Fe	mg/day	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.5-14.6[f]
Urine	Cd	µg/L	0.575	0.464	1.06	0.64	0.5-0.6	0.06-1.43	0.18-2.14	0.174-0.516	0.582-0.835	--
	Pb	µg/L	8.31	7.75	9.19	6.45	19.0-27.8	ND	ND	ND	ND	10.5±1.0[e]
	creatinine	mg/dL	ND	ND	ND	ND	ND	ND	ND	ND	ND	66-233[f]
	beta$_2$*	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	86 (geo mean)[g] 89 Male[k] 71 Female[k]
Whole blood	Cd	µg/dL	0.077	0.061	0.062	0.087	ND	0.030-0.330	0.030	0.188	ND	--
	Pb	µg/dL	9.73	9.04	12.8	10.9	11.9-21.3	ND	ND	ND	ND	12.2±4.6[h] 10.5±0.4[e]
	Fe	mg/dL	ND	ND	ND	ND	ND	ND	ND	ND	ND	43-52[f]
	hemoglobin	g/dL	ND	ND	ND	ND	ND	ND	ND	ND	ND	Male 13-18[i] Female 11-16[i]
Blood serum	Fe	µg/dL	ND	ND	ND	ND	ND	ND	ND	ND	ND	Male 61-193[i] Female 50-170[i]
	TIBC*	µg/dL	ND	ND	ND	ND	ND	ND	ND	ND	ND	281[i] 250-400[j]

ND - no data

* beta$_2$ - beta$_2$-microglobin
TIBC - total iron binding capacity

a. EPA 600/1-78-032, EPA Contract 68-02-1746, SwRI Project 01-4007 (geometric means used).

b. EPA Contract 68-02-0595, March 1974.

c. N. E. Kowal, D. E. Johnson, D. F. Kramer, H. R. Pahren, Journal of Toxicology and Environmental Health 5:995-1014, 1979.

d. EPA 600/1-78-035, May 1978.

e. Baseline Levels of Platinum and Palladium in Human Tissues. EPA-600/1-76-019, March 1976; arithmetic mean for Lancaster, California; feces µg/g adjusted to µg/day using 118 g (wet)/day as average fecal weight.

f. Biology Data Book, Volume II, P. L. Altman and D. S. Dittmer, ed. Fed. of Am. Soc. for Exp. Biology, Bethesda, Maryland, 1973.

g. S. Kojima, Y. Haga, T. Kurihara, T. Yamawaki, and T. Kjellstrom. A Comparison Between Fecal Cd and Urinary Beta$_2$-microglobulin, Total Protein and Cd Among Japanese Farmers. Environ. Research 14:436-451, 1977.

h. Epidemiologic Study of the Effects of Automobile Traffic on Blood Lead Levels. EPA 600/1-78-035, August 1978.

i. Gradwohl's Clinical Laboratory Methods and Diagnosis, Volume I. S. Frankel, S. Reitman and A. C. Sonnenwrith, eds., 7th Edition, C. V. Mosby Company, St. Louis, Missouri, 1970.

j. Pediatric Clinical Chemistry. S. Meites, editor-in-chief. Amer. Assoc. for Clinical Chemistry, Washington, D.C., 1977, pp. 146-242.

k. N. E. Kowal and F. Kraemer. Urinary Cadmiun and Beta$_2$ Microglobin Levels of Persons Ages 20-74 Years from a Subsample of the National HANSES II Survey. U.S. EPA Health Effects Research Laboratory, 1981.

is consistent with results of previous studies. Mean daily ingestion rates for both cadmium and lead estimated from the levels found in feces are corresponding low: 6 to 15 µg/day cadmium and 16 to 54 µg/day lead. The levels of zinc (5 to 11 mg/day) found in feces are somewhat lower than values reported in other studies and the levels of calcium (299 to 661 mg/day) and iron (5 to 11 mg/day) are within the ranges reported in other studies. From these data, it would appear that the diet of the urban hispanics immediately preceding the sampling period did not contain problem levels of these metals.

In urine, the mean levels of cadmium ranged 0.42 to 0.98 µg/L when adjusted for specific gravity; unadjusted values ranged 0.35 to 0.63 µg/L. These values are very similar to values reported in previous studies. The mean levels of lead in urine ranged 2 to 5 µg/L, adjusted, and 1 to 3 µg/L, unadjusted. These measured lead levels in urine are considerably lower than values commonly reported in other studies; values in the neighborhood of 10 µg/L are common. Because urine is a medium which reflects body burden levels of heavy metals, it is estimated that the body burdens of cadmium in the urban hispanic study population are similar to those of the general population, and body burdens of lead are lower than those of the general population. The mean levels of beta$_2$-microglobulin found in urine ranged 40 to 132 µg/L. These compare to levels ranging 76 to 89 in the general population. The highest mean of 132 µg/L was measured for females over 50 years of age. The normal range of urinary beta$_2$-microglobulin is up to 400 µg/L, and 3600 µg/L represents an advanced state of proteinuria. Only seven of the hispanic participants showed beta$_2$-microglobulin in excess of 400 µg/L and none were found above 3600 µg/L. There was no apparent correlation between cadmium levels and elevated beta$_2$-microglobulin in urine.

In blood, the mean levels of cadmium ranged 0.11 to 0.18 µg/dL; these levels are somewhat higher than values previously found for a population in Chicago (0.08 to 0.09 µg/dL) and somewhat lower than values previously found for a population in Dallas (0.19 µg/dL). Mean levels of blood lead ranged 4 to 9 µg/dL; these levels are low compared to levels found previously in the general population. Because blood levels relate to recent exposures, these levels of cadmium and lead would indicate that the urban hispanic study population was exposed to similar or lower levels of cadmium and lead than the general population. Levels of iron, TIBC and hemoglobin were found to be well within the normal ranges reported in previous studies. There was no apparent iron deficiency in the study population.

Analyses of the effects of smoking indicate a higher level of cadmium in urine in smokers versus nonsmokers. This is in agreement with previous studies. No apparent correlation was determined for smoking/nonsmoking for cadmium levels in blood or for lead levels in either blood or urine. The possible association between urine cadmium levels (body burden) and urine beta$_2$-microglobulin levels was investigated and no association was found. The possible association of iron deficiency and blood cadmium levels was examined and no association was found.

Rural Blacks

The mean values of cadmium found in feces ranged 10 to 16 µg/day for males and 7 to 11 µg/day for females; mean values for lead in feces ranged 37 to 74 µg/day for males and 36 to 37 µg/day for females. These levels are lower than levels reported previously for the general population. The lower values for females than for males for these metals is consistent with results of previous studies. Mean daily ingestion rates for both cadmium and lead estimated from the levels found in feces are correspondingly low: 7 to 17 µg/day cadmium and 40 to 82 µg/day lead. The levels for zinc (7 to 13 mg/day) found in feces are similar to the levels found in previous studies and the levels of calcium (403 to 602 mg/day) and iron (5 to 8 mg/day) are within the ranges reported in other studies. From these data it would appear that the diet of the rural blacks immediately preceding the sampling period did not contain problem levels of these metals.

In urine, the mean levels of cadmium ranged 0.36 to 0.73 µg/L when adjusted for specific gravity; unadjusted values ranged 0.25 to 0.47 µg/L. These values are very similar to values reported in previous studies. The mean levels of lead in urine ranged 5 to 9 µg/L, adjusted, and 4 to 6 µg/L, unadjusted. These measured values in urine are lower than values reported in previous studies. Because urine is a medium which reflects body burden levels of heavy metals, it is estimated that the body burdens of cadmium in the rural black study population are similar to those of the general population, and the body burdens of lead are lower than those of the general population. The mean levels of beta$_2$-microglobulin found in urine ranged 26 to 39 µg/L. These levels are low in comparison to levels reported from previous studies. Only three of the black participants showed beta$_2$-microglobulin levels in excess of 400 µg/L and the highest was 780, far below the 3600 µg/L which represents advanced state of proteinuria. There was no apparent correlation between cadmium levels and elevated beta$_2$-microglobulin in urine.

In blood, the mean levels of cadmium ranged 0.06 to 0.12 µg/dL; these levels are similar to levels reported previously for a population in Chicago and lower than values previously found for a population in Dallas. Mean levels of blood lead ranged 8.6 to 13.9 µg/dL; these levels are similar to values reported in previous studies for the general population. Because blood levels relate to recent exposures, these levels of cadmium and lead would indicate that the rural black study population was exposed to levels of cadmium and lead similar to these exposures in the general population. Levels of iron in blood were well within the normal range. There is no apparent iron deficiency in the study population.

Analysis of the effects of smoking indicate a higher level of cadmium in urine in smokers versus nonsmokers. This is in agreement with previous studies. No apparent correlation was determined for smoking/nonsmoking for cadmium levels in blood or for lead levels in either blood or urine. The possible association between urine cadmium levels (body burden) and urine beta$_2$-microglobulin levels was investigated and no association was found. The possible association of iron deficiency and blood cadmium was examined and no association was found.

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APPENDIX A

RECRUITMENT MATERIALS

Hand-out materials used to recruit the study populations are presented in this appendix.

Daily Intake on Cadmium and Lead in Selected Populations - 1980
How About an Extra $25 (Marion County)
How About an Extra $25 (San Antonio)

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DAILY INTAKE OF CADMIUM AND LEAD
IN SELECTED POPULATIONS - 1980

Summary

There is concern that toxic metals such as cadmium and lead may be consumed in food and beverages by some parts of the population in quantities that approach toxic levels. During recent years an international effort has been directed at measurement of the ingestion rates of these metals in selected populations. Populations surveyed to date include elements of the population in Japan exposed to environmental pollution from mining operations, persons in Sweden occupationally exposed to these metals, workers in New Zealand exposed to oysters with high levels of these metals, vegetarians in California consuming foods with higher levels of cadmium, white population in Dallas, Texas with no outstanding industrial or environmental exposures, the general population, primarily white, residing near a water treatment plant in an Illinois community, and others. In this phase of the continuing effort, two population groups in the U.S. will be studied: rural blacks and urban hispanics.

Sponsor Organizations

This survey is sponsored by the Environmental Protection Agency and conducted through a cooperative effort with Southwest Research Institute.

Study Sites

San Antonio, Texas: Urban Hispanics
Eastern Texas: Rural Blacks

Participants Required: 240

	Urban Hispanics	Rural Blacks
School Children, 12-18 years of age	60	60
Adults, 50 or more years of age	60	60
Equal members of males and females	120	120

Obtained from Each Participant

Two 24-hr fecal samples
One 24-hr urine sample
One blood sample (obtained by medical technician)
Health and diet information

Received by Participants

$25.00 in partial compensation for their services
Certificate of Appreciation
Results of the survey

HOW ABOUT AN EXTRA $25

Summary

To determine the daily consumption of certain chemicals (cadmium and lead) Southwest Research Institute is performing a study for the Environmental Protection Agency. We are looking for people who live in Marion County. From each person we need samples of urine, stool, and blood.

Participants Needed

120 residents of Marion County

	Males	Females
Persons ages 12-18 years	30	30
Adults age 50 or more years	30	30
Total	60	60

Samples Needed from Each Participant

One 24-hr urine sample
Two 24-hr stool samples
One blood sample

Sample Collection

These samples will be collected over a two day period and each volunteer will be paid $25 when the samples have been collected. Volunteers will be asked to provide information regarding diet and general health. Sample collection containers will be provided for urine and stool. The blood sample will be collected by a medically trained technician.

Payment for Volunteer Participants

$25 for services paid to each volunteer

Complete Information Regarding this Program will be Given Out

Where:

When:

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HOW ABOUT AN EXTRA $25

Summary

To determine the daily consumption of certain chemicals (cadmium and lead) Southwest Research Institute is performing a study for the Environmental Protection Agency. We are looking for people who live in the near west side of San Antonio. From each person we need samples of urine, stool, and blood.

Participants Needed

120 residents of westside San Antonio:

	Males	Females
Persons aged 12-18 years	30	30
Adults aged 50 or more years	30	30
TOTAL	60	60

Samples Needed from Each Participant

One 24-hr urine sample
Two 24-hr stool samples
One blood sample

Sample Collection

These samples will be collected over a two day period and each volunteer will be paid $25 when the samples have been collected. Volunteers will be asked to provide information regarding diet and general health. Sample collection containers will be provided for urine and stool. The blood sample will be collected by a medically trained technician.

Payment for Volunteer Participants

$25 for services paid to each volunteer.

Complete Information Regarding this Program will be Given Out

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APPENDIX B

THE SAMPLE COLLECTION KIT AND INSTRUCTIONS REGARDING PROPER SAMPLE COLLECTION AND STORAGE

The sample container kit provided to each participant in this study contained the following items:

1) one small disposable (styrofoam) ice chest;
2) one paper shopping bag;
3) one instruction sheet;
4) one 2-liter, wide-mouth, screw-top polyethylene jug for urine collection;
5) one small, wide-mouth, screw-top polyethylene jar for urine collection (females only);
6) two 1-quart snap-top tubs with attached apparatus for placing on toilet for feces collection (Sage Products, 2400 Comode Specimen System);
7) two Blue Ice packs.

The ice chest was provided to keep feces and urine samples refrigerated until delivered to the field team. Photographs of the sample container kit and its contents are presented in this appendix with a copy of the instruction sheet for proper sample collection and storage. Photograph 1 shows the principal contents of the kit: one 2-liter jar for urine collection, two feces sample containers with apparatus for placing on toilet, and two Blue Ice packs for keeping the collected samples cool. Photograph 2 shows the sample containers and ice packs stowed in the bottom of the ice chest. Photograph 3 shows the proper placement of the feces sample container on the toilet with the toilet set raised. Photograph 4 shows the feces sample container in place with the toilet seat lowered. Photograph 5 shows the feces sample container with lid removed, ready for sample collection. Photograph 6 shows the Blue Ice pack being placed in freezer to prepare it for use in keeping the collected samples cool. The instruction sheet included in each sample container kit is presented in Figure B-1.

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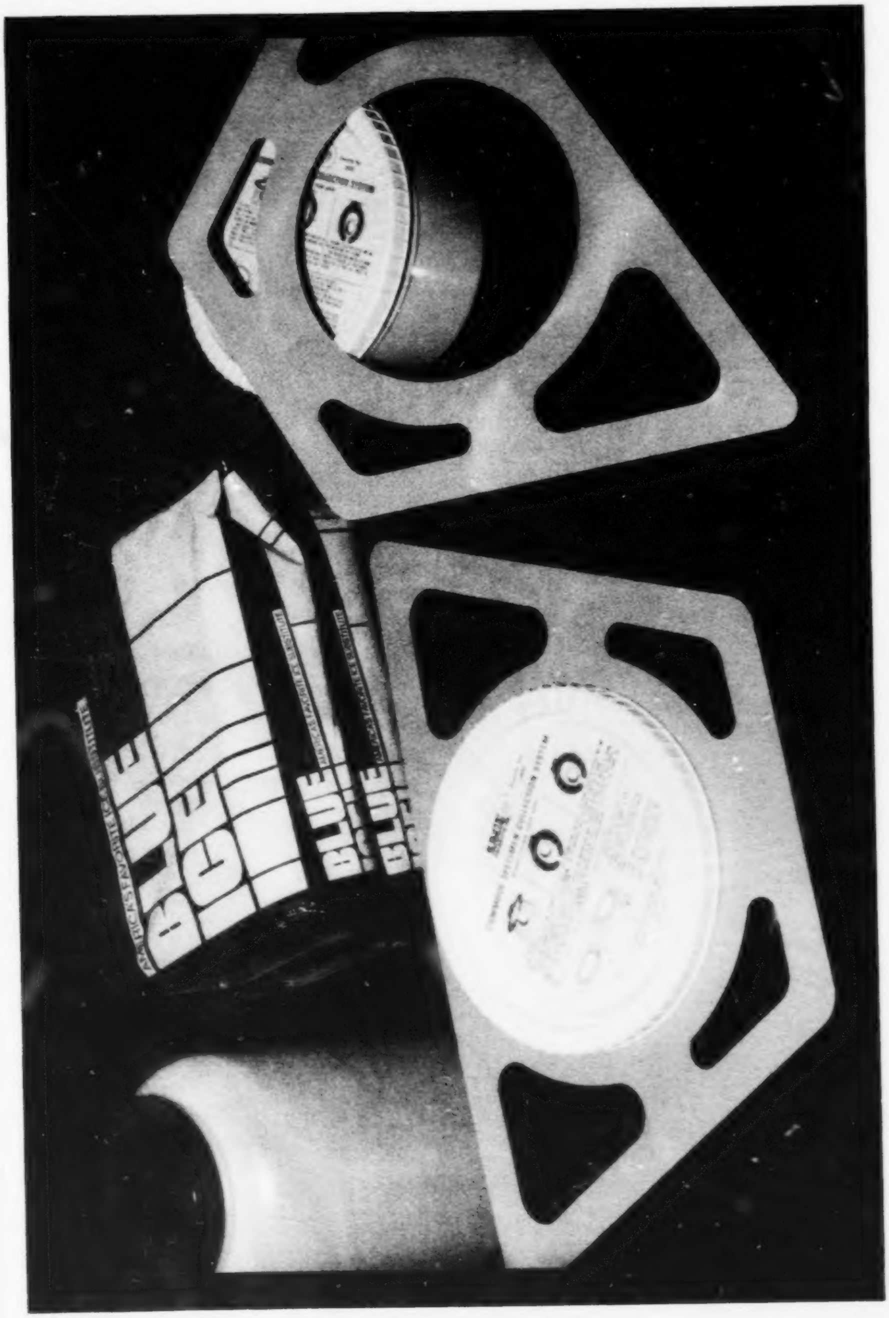

PHOTOGRAPH 1

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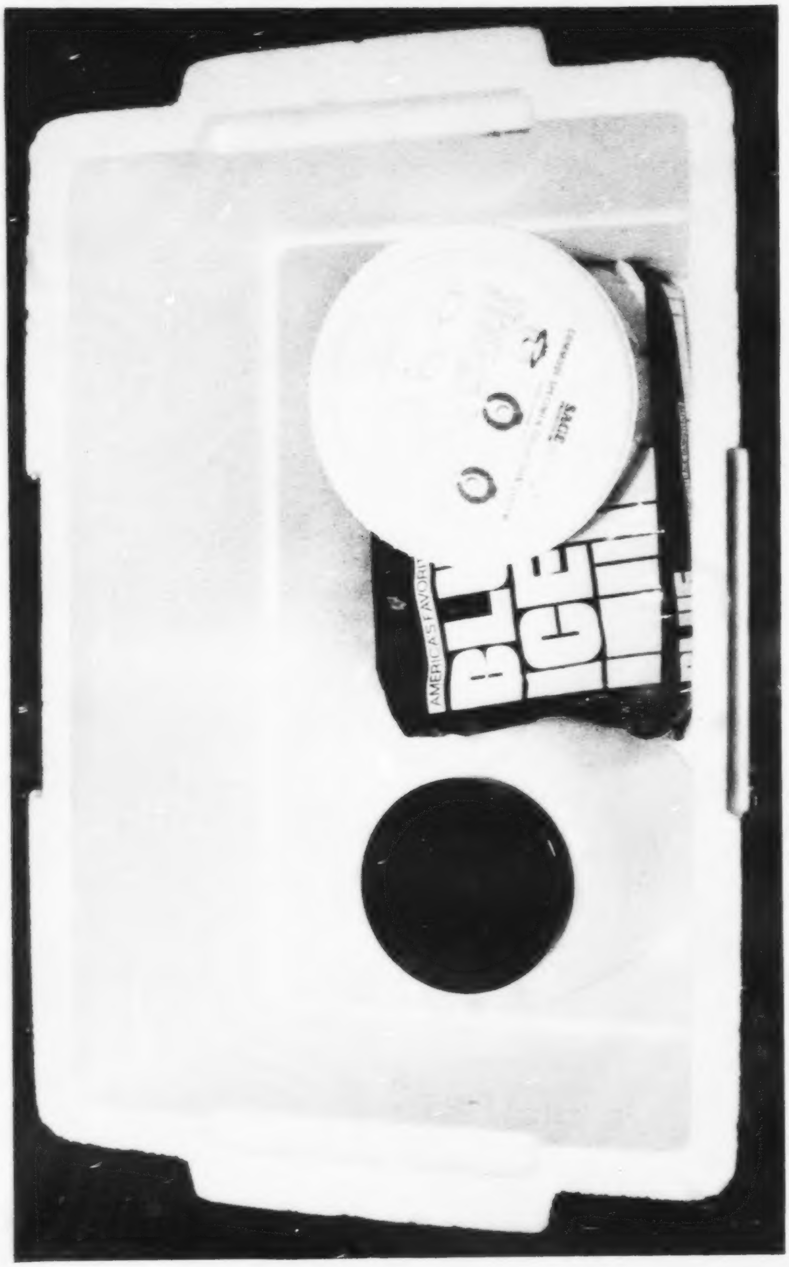
AMERICA'S FAVORITE
BLUE ICE
SAGE

PHOTOGRAPH 2

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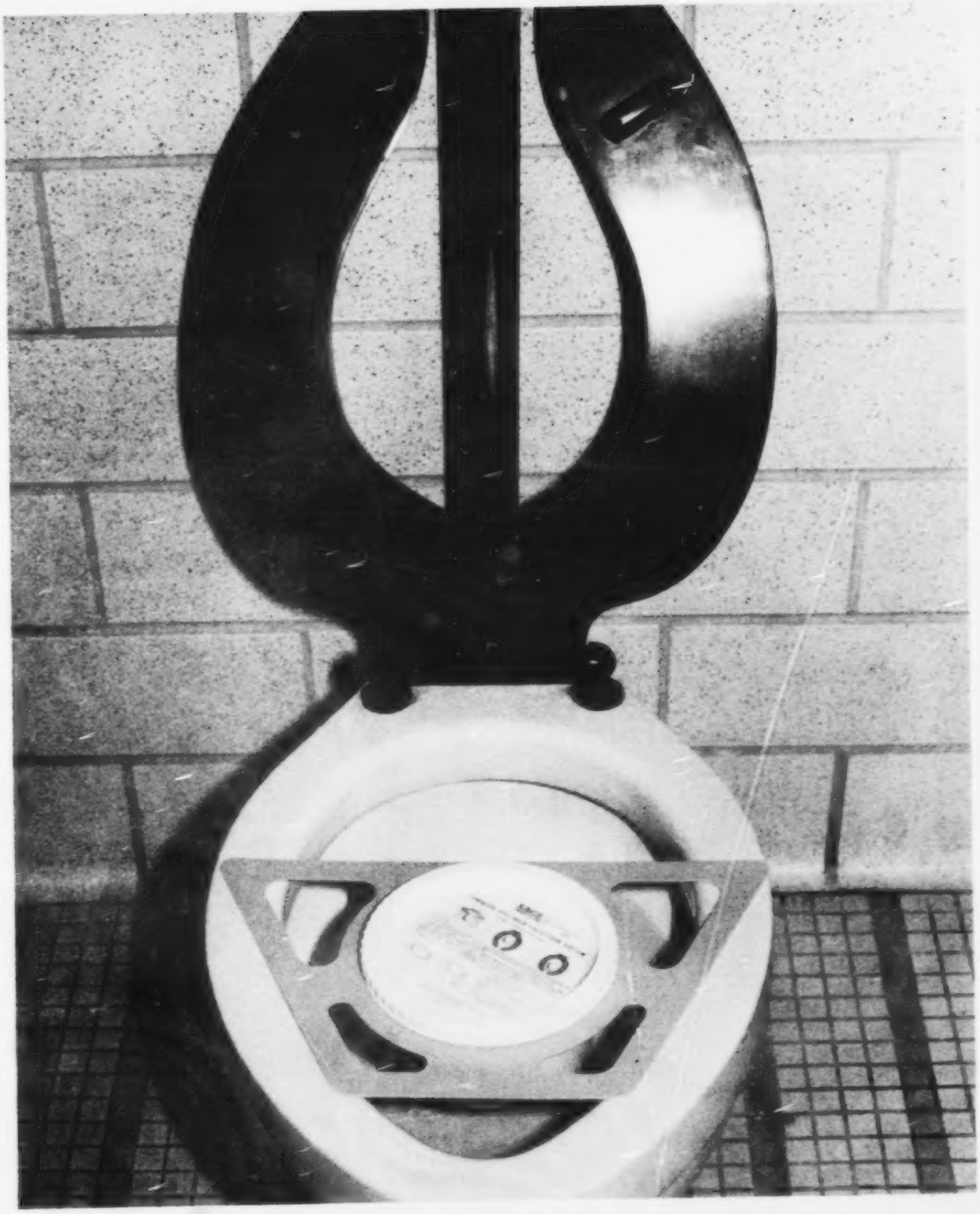

PHOTOGRAPH 3

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PHOTOGRAPH 4

PHOTOGRAPH 5

BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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AMERICA'S FAVORITE ICE SUBSTITUTE.
BLUE ICE

PHOTOGRAPH 6

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INSTRUCTION SHEET

The success of this research project depends on your complete cooperation. Only through the assistance of volunteers, such as you, can we obtain information on environmental pollutants. Incomplete sampling of urine, feces and blood will produce incomplete information, so please follow these instructions.

Urine Collection

(1) You will be given a urine collection bottle that has been cleaned in a special manner. Please avoid introducing anything else into this bottle other than urine.

(2) Beginning in the morning, when you get out of bed, you will begin collecting all of your urine in the container provided. Please urinate into this container each time you urinate until you get up the next morning.

(3) The collection bottle should be capped tightly after each use, and kept in the ice chest with a frozen "blue ice" bag.

Feces Collection

(1) You will also be given two collection containers for feces that have been cleaned in a special manner. Your feces will be the only contents placed in these containers.

(2) The blue toilet assembly has been provided for your convenience in feces collection. Place it on the toilet bowl as shown in the instructions included with the kit. As with the urine collection, begin collecting all of your feces upon rising in the morning and continue until the following morning. Then use the second container and repeat the collection sequence.

(3) When collecting your specimen, be sure not to mix any urine or toilet paper with the feces. Analysis cannot be done on a sample that has been mixed with urine or paper. Also, take great care not to contaminate the outside of the collection vessel with feces because there may be potentially serious consequences to those handling the specimen. The blue plastic support device should be snapped off the feces container once that container has been used.

(4) After the feces has been collected, keep it in the ice chest with a frozen "blue ice" bag.

(5) Two "blue ice" bags are provided. Keep one frozen bag in the ice chest at all times and the other in the freezer unit. Alternate when bag thaws.

Please bring your urine, and feces specimens to the collection point at the designated time.

Thank you very much for your help.

Figure B-1. Instruction sheet for sample collection

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APPENDIX C

RECRUITMENT AND SAMPLING: SAN ANTONIO, TEXAS

INTRODUCTION

Site selection for the study was begun in mid-March. Recruitment and sampling for the urban hispanic component of the study was begun in June and completed in mid-August. Total numbers of participants recruited and sampled in San Antonio exceeded the required 120 participants. Numerous valuable experienced were encountered during the completion of the San Antonio activity, many of which provided aid in the completion of the subsequent activity in eastern Texas.

SITE SELECTION AND INITIAL CONTACTS

Site selection was accomplished through a review of 1970 census data for selected urban tracts in San Antonio and a comparison against U.S. totals, Texas totals, and the lower Rio Grande Valley of Texas. San Antonio compared favorably against other areas with high concentrations of urban hispanics. A 13-tract area was delineated as the possible study site, with four tracts being of particular interest to the study team.

It was considered to be to the advantage of the study to obtain cooperation of the Mexican-American Unity Council (MAUC), a citizen action agency on the westside barrio. Efforts to obtain the cooperation of MAUC were successful and MAUC provided office space for the recruitment coordinator and recruitment and sampling space in the auditorium of the MAUC community center. The pretige of MAUC in the Mexican-American comunity was also a useful factor in recruitment of volunteers.

A bilingual coordinator was chosen from among current job applications to MAUC. Hired as a temporary Institute employee, he was provided office space at MAUC, a phone and secretarial assistance. The coordinator immediately began making contact with potential participants through the local Edgewood Independent School District (EISD) for 12 to 18 year olds and through nearby community centers for 50+ year olds.

PREPARATIONS FOR RECRUITMENT AND SAMPLING

As all high school summer programs within the EISD were concentrated at nearby Memorial High School, clearance was obtained from that school's principal to recruit students with a particular focus upon science-oriented classes. Auditorium space at Memorial was provided and equivalent space was arranged for at MAUC.

Approximately 140 sample kits were prepared with computer-generated labels for proper tracking of feces, urine, blood samples and associated paper work. A step-by-step protocol for recruitment and sampling was developed, and a briefing for all involved full-time and part-time staff was held.

A cargo-sized van was rented for transport of sample kits and collected samples as well as medical screens for the blood-drawing phase. Smocks with the SwRI logo were obtained for all team members and photos prepared of sample kit contents for use as a visual aid to the participants. Press releases were generated and distributed and news articles appeared in each of the two major daily San Antonio newspapers immediately preceding the sampling activities.

RECRUITMENT AND SAMPLE COLLECTION

June 26, 1980 was scheduled as the first day of recruitment and sampling at Memorial High School. The recruitment coordinator has prebriefed several science-oriented classes and distributed informed consent forms for perusal and signature by both participants and parent/guardians. Established protocol for recruitment and sampling was as follows:

- confirmation of completed informed consent forms;
- assignment of sample collection kits and explaining use of contents;
- drawing of blood samples;
- completion of health history forms;
- collection of urine and fecal samples over the weekend;
- delivery of stored samples to study team on Monday;
- immediate provision of 25 compensation to all participants completing study requirements.

June 27, 1980 was the first scheduled day of collection at the MAUC facility. The same protocol was followed as above. Samples were collected by all recruited participants over the weekend of June 28 and 29, with delivery of urine and feces samples scheduled for June 30 with July 1 held in reserve as a backup day.

It was necessary to make one more recruitment and sampling effort at MAUC over the weekend of July 18 to 21 to nearly complete the required number of participants for the 50+ age group. An additional four participants were recruited and sampled through the efforts of SwRI permanent staff. The results of the recruitment and sampling effort are presented in Table C-1. A total of 137 persons participated in the study. Of these, 123 persons provided all required samples and information and an additional 14 persons provided some, but not all, of the samples and conformation sought. In general, those providing only part of the required samples and information were lacking in only one of the four items sought: eight were lacking stool samples and seven lacked blood samples.

TABLE C-1. RECRUITMENT AND SAMPLING RESULTS--SAN ANTONIO, TEXAS JUNE-AUGUST 1980

Age group	Sex	Total participants	Participants providing all samples AND information	Participants providing partial samples AND information
12-18	M	40	36	4
	F	34	27	7
	Total	74	63	11
50+	M	32	30	2
	F	31	30	1
	Total	63	60	3
GRAND TOTAL		137	123	14

* Health history, blood sample, 24-hour urine sample, two 24-hour stool samples.

OBSERVATIONS AND COMMENTS

The highest "dropout" and "no-show" rates were among the 12 to 18 year old group. Exact reasons for this are unclear other than such immediate rationales as peer group pressures or nonattention due to the captive audience environment of the high school.

In addition, samples supplied by the 12 to 18 year old group and to a limited extent by the 50+ year olds initially tended to be smaller than would normally be collected during a 24-hour period. It was concluded that insufficient instructions were provided as to what constituted a 24-hour sample, and steps were taken to provide adequate instructions through:

- oral briefing emphasis upon 24-hour nature of specimens;
- provision of a detailed instruction sheet with the collection kit;
- provision of a participant urine and feces log for emphasis upon the serial nature of the collection process.

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As a result of these precautions, delivered samples during the second recruitment and sampling phase were more uniformly representative of a 24-hour sample.

It was noted that during the inital recruitment and sampling phase many of the urine samples were extremely concentrated. The situation was resolved when pointed out by an SwRI staffer that temperatures peaked at or over 100°F every day 2 weeks prior to and during the sampling period.

The processing of participants, it was noted, took approximately one hour per ten participants. In the case of the elderly participants, the availability of bilingual SwRI staff for completion of the health history forms was insufficient; as a result, the processing of participants at that stage slowed down. No language difficulties were experienced with the 12 to 18 year old participants.

APPENDIX D

RECRUITMENT AND SAMPLING: MARION COUNTY, TEXAS

INTRODUCTION

Marion County, Texas was selected as the study site for recruitment of rural blacks. The site was visited on August 14 and 15, 1980 to evaluate the appropriateness of the site and make initial local contacts and again on September 17, 1980 to make final arrangements for recruitment and sampling. Volunteers were recruited by two site coordinators retained locally and sampling activities were conducted in Marion County October 10 to 13. The total number of participants recruited and sampled exceeded the required 120 participants.

SITE SELECTION AND INITIAL CONTACTS

A review of 1970 census data yielded a number of rural counties in eastern Texas to be potentially well suited for recruitment and sampling of a rural, low income black population. One possible site in San Augustine County was visited and found to be less than optimum as a study site. The local government and particularly the medical officers of the municipal and county governments did not indicate support of the study. A previous study regarding nutrition had evidently given the town some bad publicity and the two M.D.'s who practiced there were particularly sensitive. Contact with the Texas Department of Health confirmed the inappropriateness of that community for the kind of study we were conducting. Dr. Charles Webb, state epidemiologist, Texas Department of Health, suggested another of the counties under consideration, Marion County, Texas, due to presence of low income blacks and a recent history of public cooperation with an epidemiology study regarding mercury poisoning. Further investigations led to the conclusion that the mercury poisoning was an isolated incident and that Marion County would supply an adequate base for the study.

The Texas Department of Health regional office in Tyler, Dr. M. Crowder, regional director, offered to support the project activities by allowing the project staff to operate out of the Department of Health office in Jefferson, Texas. Wilmer West, M.D., the physician in charge of the Jefferson office, indicated a personal interest in the study due to his interest in trace metals. Other significant sources of local support to the study were obtained in the community. The Douglas Memorial Hospital, under the direction of Dr. C. A. Darby, is oriented to serving the black community in Marion County. Dr. Darby offered his complete support to the study and allowed his personnel to serve in the blood sampling activities. The Marion County Education and Recreation Center in Jefferson, Texas was made available for recruitment and sampling activities in that community and the Smithland Community Center was made available for similar activities in a more rural area of the county.

PREPARATIONS FOR RECRUITMENT AND SAMPLING

The plan for recruitment and sampling in Marion County centered on two subject groups, one residing in a primarily black residential area in the western portion of the town of Jefferson in the vicinity of State Highway 49. The second group resides east of Jefferson in a rural community known as Smithland, approximately 13 miles east and north of the town off State Highway 49. Two site coordinators were retained to recruit the 120 subjects needed. One coordinator resides in each of the sites described. Mrs. Frances Melton, LVN, who resides in west Jefferson, was in charge of recruitment of recruiting half of the subjects needed. Mrs. Lillie Steward, who resides in the Smithland area, was in charge of recruitment in that area. Local church groups and school organizations were utilized by the site coordinators to approach and enlist volunteers.

Approximately 140 sample kits were prepared with computer-generated labels for proper tracking of feces, urine, blood samples, and associated paper work. The step-by-step protocol developed for recruitment and sampling was reviewed with all members of the survey team.

A cargo truck was rented for transport of sample skits and collected samples as well as medical screens for the blood-drawing phase. Smocks with the SwRI logo were obtained for all team members and photos prepared of sample kit contents for use as a visual aid to the participants. A press release was generated and distributed resulting in a news article on the study in the local newspaper in Jefferson, Texas, immediately preceding the sampling activities.

RECRUITMENT AND SAMPLE COLLECTION

Two community centers, one located in each of the areas discussed previously, were used as bases of activity for recruitment and sampling. The schedule of recruitment and sampling activities is presented in Table D-1.

TABLE D-1. SCHEDULE FOR RECRUITMENT AND SAMPLING ACTIVITIES: MARION COUNTY, TEXAS

Wednesday, October 8	Load truck
Thursday, October 9	Travel to Jefferson
Friday, October 10	8 AM-1 PM, Marion County Education and Recreation Center Jefferson, Texas 2 PM-7 PM, Smithland Community Center Smithland, Texas
Monday, October 13	8 AM-1 PM, Marion County Education and Recreation Center Jefferson, Texas 2 PM-7 PM, Smithland Community Center Smithland, Texas
Tuesday, October 14	Travel to San Antonio
Wednesday, October 15	Unload truck

A four-member project survey team met with recruits on Friday, October 10, at each of the two community centers to enroll the study participants, instruct them in sample collection procedure, and provide them with sample collection containers. The site coordinators had prebriefed the local population and assembled the volunteers at the two community centers at the scheduled times. Local medical professionals were retained from the Douglas Memorial Hospital for the blood sampling activities. Urine and feces samples were collected over the weekend of October 11 and 12 and delivered to the study team on October 13 at the community centers. Participants completing all study requirements (health history, blood sample, 24-hour urine sample, and two 24-hour stool samples) were given a $25 check on October 13. Individuals not providing adequate urine or stool samples were allowed to deliver the missing samples on the morning of October 14. (Seven participants delivered samples and received the $25 check on October 14.)

The results of the recruitment and sampling activities in Marion County are presented in Table D-2. A total of 136 persons participated in the study. Of these, 124 persons provided all required samples and information and an additional 12 persons provided partial samples and information sought. In general, those providing only part of the required samples and information were lacking in only one of the four items sought. Stool samples were the type most frequently omitted.

TABLE D-2. RECRUITMENT AND SAMPLING RESULTS--MARION COUNTY OCTOBER 1980

Age group	Sex	Total participants	Participants providing all samples AND information	Participants providing partial samples AND information
12-18	M	34	30	4
	F	40	37	3
	Total	74	67	7
50+	M	29	27	2
	F	33	30	3
	Total	62	57	5
GRAND TOTAL		136	124	12

* Health history, blood sample, 24-hour urine sample, two 24-hour stool samples.

OBSERVATIONS AND COMMENTS

The participants in Marion County were extremely cooperative and conscientious of the study requirements. Some samples appeared to be less than 24-hour samples, but the frequency of such samples was less than that experienced in San Antonio. The steps employed during the latter phases of San Antonio sampling to attempt to acquire a better 24-hour urine sample were employed in Marion County. These steps include more complete instructions and use of a urine and feces log with emphasis or serial urine samples. Some participants were excused from one of the fecal samples due to age and persons with poor veins with respect to venipuncture were excused after one attempt with no results.

APPENDIX E

INTERVIEW GUIDE

The metals ingestion study interview guide is presented in Figure E-1.

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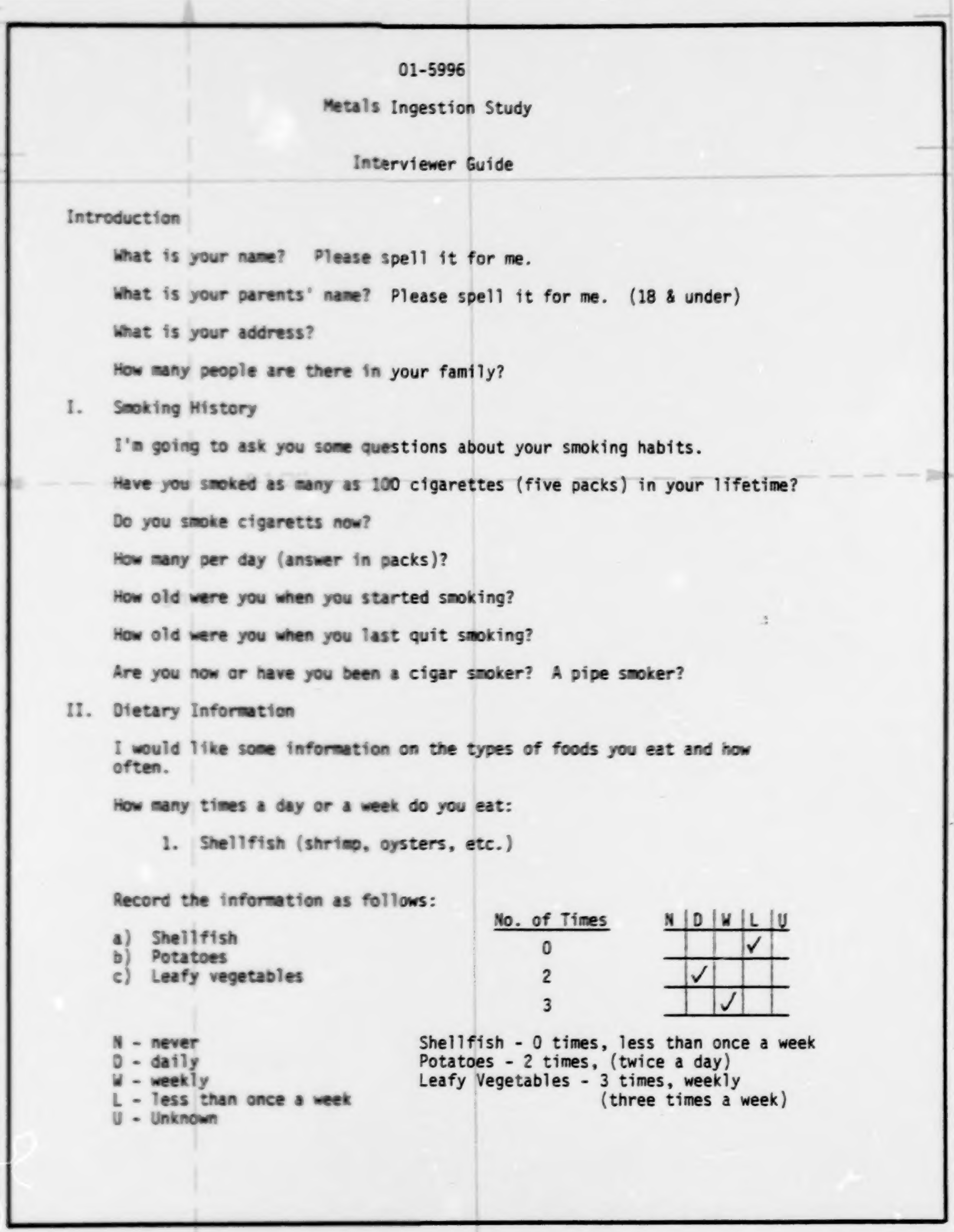

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Metals Ingestion Study

Interviewer Guide

Introduction

What is your name? Please spell it for me.

What is your parents' name? Please spell it for me. (18 & under)

What is your address?

How many people are there in your family?

I. Smoking History

I'm going to ask you some questions about your smoking habits.

Have you smoked as many as 100 cigarettes (five packs) in your lifetime?

Do you smoke cigaretts now?

How many per day (answer in packs)?

How old were you when you started smoking?

How old were you when you last quit smoking?

Are you now or have you been a cigar smoker? A pipe smoker?

II. Dietary Information

I would like some information on the types of foods you eat and how often.

How many times a day or a week do you eat:

1. Shellfish (shrimp, oysters, etc.)

Record the information as follows:

	No. of Times	N	D	W	L	U
a) Shellfish	0				✓	
b) Potatoes	2		✓			
c) Leafy vegetables	3			✓		

N - never
D - daily
W - weekly
L - less than once a week
U - Unknown

Shellfish - 0 times, less than once a week
Potatoes - 2 times, (twice a day)
Leafy Vegetables - 3 times, weekly
(three times a week)

Figure E-1. Interviewer guide

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Do you take any of the following vitamins or minerals?

If yes, regularly or irregularly?

Are you on any special diet? Please tell me about it.

How long have you been on this diet?

III. Medical History

I'm going to ask you about some health problems you may have had.

Please tell me if you've ever been treated for:

Any problems with kidneys?

What was it?
When were you first treated?
When were you last treated?

Example:

	yes	no					
Kidney disease	✓		7	5	7	8	Kidney Stones
Cancer	✓		7	8	8	0	Cancer of lymph nodes

IV. Personal Information

Lastly, I'd like some information on you and your family.

What is your age?

(Record Sex)

How much do you weigh?

How long have you lived at your present address?

If less than two years, how long in San Antonio?

What kind of work do you do most of the time?

Who is the head of your household?

How many years did he/she attend school?
Did he/she graduate from high school?
Did he/she go to college?

I'm going to ask you about your family income. I have five ranges of income, 0-5, 5-10, 10-15, 15-20, and 20 or more thousands per year. Please tell me which one describes your family's total income, not counting taxes?

Figure E-1. (Cont'd)

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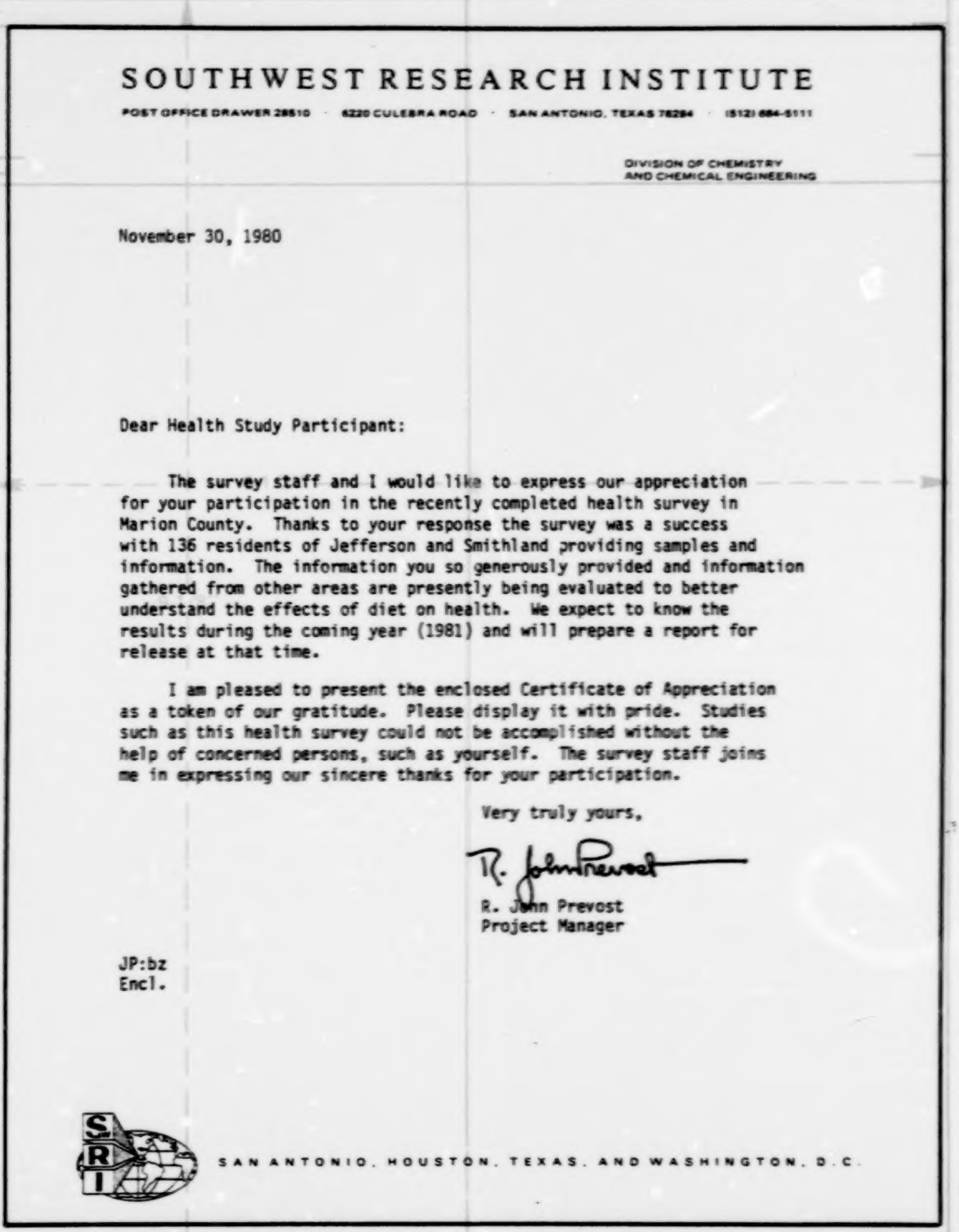
APPENDIX F

CERTIFICATES OF APPRECIATION

A letter of presentation (Figure F-1) and the certificates of appreciation (Figures F-2 and F-3) are presented in this appendix.



SOUTHWEST RESEARCH INSTITUTE
POST OFFICE DRAWER 28510 · 6220 CULEBRA ROAD · SAN ANTONIO, TEXAS 78284 · (512) 684-5111

DIVISION OF CHEMISTRY
AND CHEMICAL ENGINEERING

November 30, 1980

Dear Health Study Participant:

The survey staff and I would like to express our appreciation for your participation in the recently completed health survey in Marion County. Thanks to your response the survey was a success with 136 residents of Jefferson and Smithland providing samples and information. The information you so generously provided and information gathered from other areas are presently being evaluated to better understand the effects of diet on health. We expect to know the results during the coming year (1981) and will prepare a report for release at that time.

I am pleased to present the enclosed Certificate of Appreciation as a token of our gratitude. Please display it with pride. Studies such as this health survey could not be accomplished without the help of concerned persons, such as yourself. The survey staff joins me in expressing our sincere thanks for your participation.

Very truly yours,

R. John Prevost

R. John Prevost
Project Manager

JP:bz
Encl.

SAN ANTONIO, HOUSTON, TEXAS, AND WASHINGTON, D.C.

Figure F-1. Letter of appreciation

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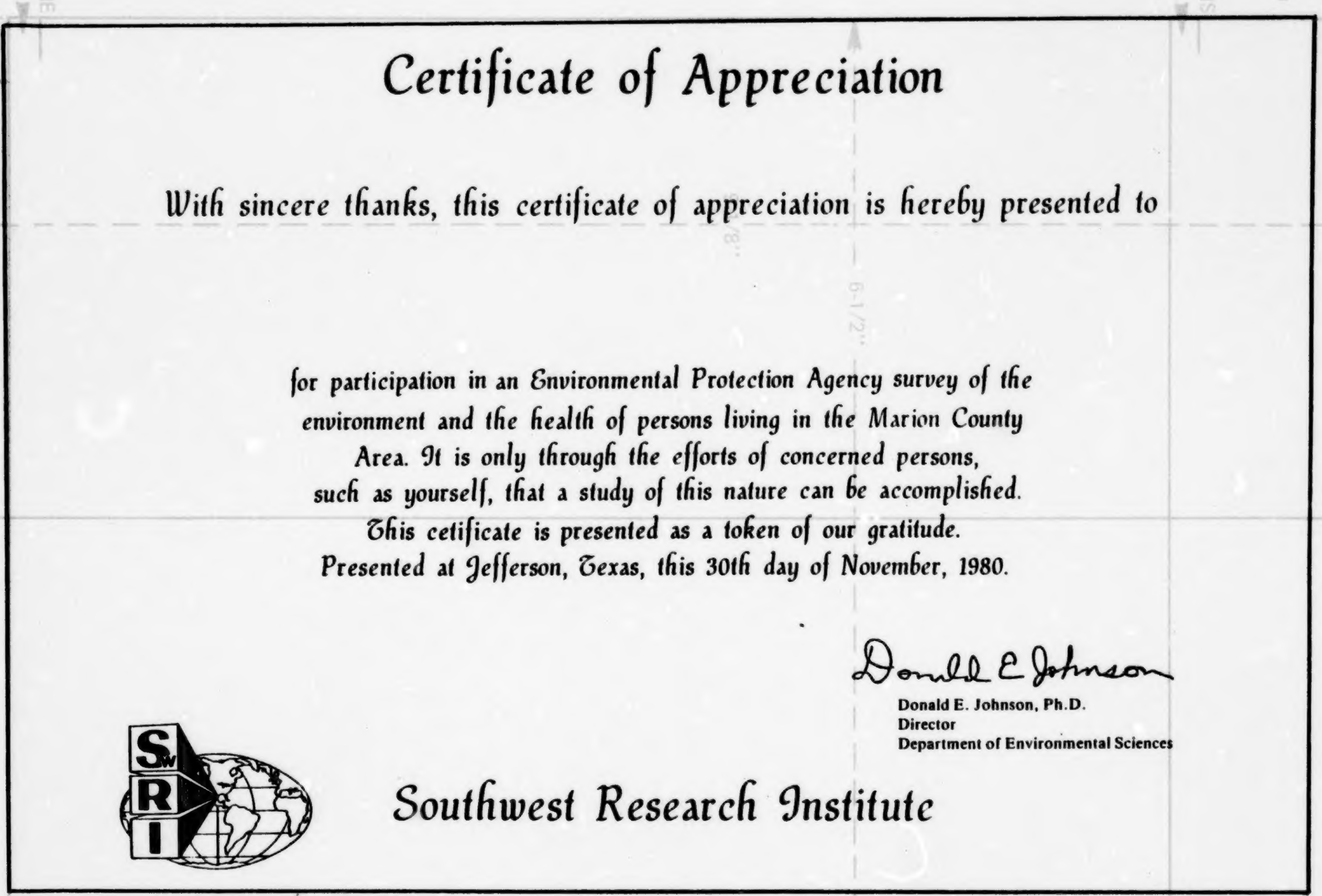

Certificate of Appreciation

With sincere thanks, this certificate of appreciation is hereby presented to

for participation in an Environmental Protection Agency survey of the environment and the health of persons living in the Marion County Area. It is only through the efforts of concerned persons, such as yourself, that a study of this nature can be accomplished.

This cetificate is presented as a token of our gratitude.

Presented at Jefferson, Texas, this 30th day of November, 1980.

Donald E Johnson

Donald E. Johnson, Ph.D.
Director
Department of Environmental Sciences

Southwest Research Institute

Figure F-2. Certificate of appreciation for participants in Marion County

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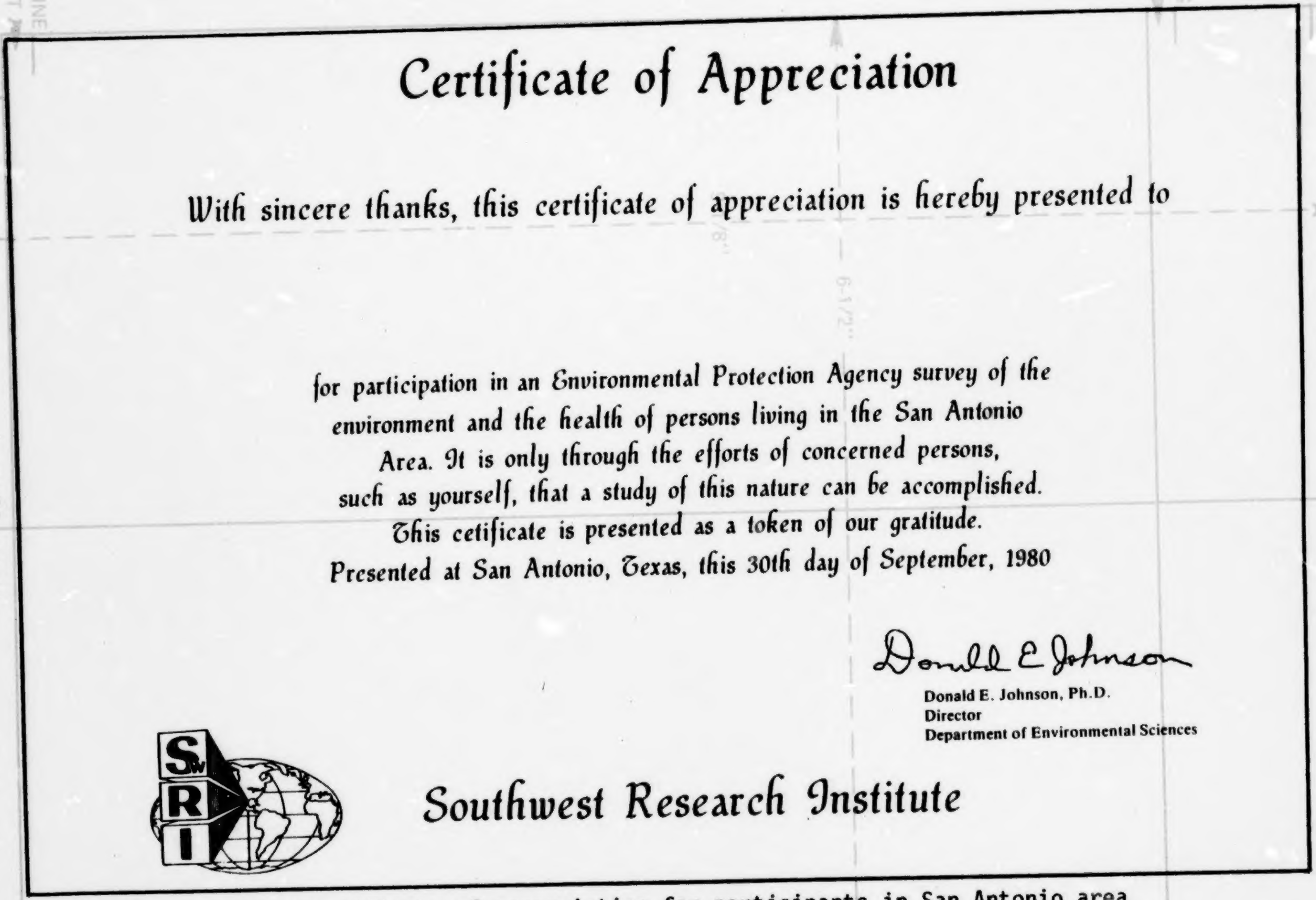

Certificate of Appreciation

With sincere thanks, this certificate of appreciation is hereby presented to

for participation in an Environmental Protection Agency survey of the
environment and the health of persons living in the San Antonio
Area. It is only through the efforts of concerned persons,
such as yourself, that a study of this nature can be accomplished.
This cetificate is presented as a token of our gratitude.
Presented at San Antonio, Texas, this 30th day of September, 1980

Donald E Johnson

Donald E. Johnson, Ph.D.
Director
Department of Environmental Sciences

Southwest Research Institute

Figure F-3. Certificate of appreciation for participants in San Antonio area

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APPENDIX G

CHEMICAL ANALYSES RESULTS

The results of the clinical chemical analyses and the trace metals analyses are presented in the appendix separately for each of the study participants. Where analysis was performed on more than one sample or on separate split samples, each of the results is presented separately.

Table G-1. Analysis of 24-Hour Urine Samples
Table G-2. Analysis of Blood Samples
Table G-3. Analysis of 24-Hour Feces Samples

TABLE G-1. ANALYSIS OF 24-HOUR URINE SAMPLES

Participant			Volume	Specific	Cd	Pb	Beta$_2$-microglobulin		Creatinine	
ID	Sex	Age	L	gravity	ug/L	ug/L	ug/da		mg/dL	g/da
01	F	17	1.22	1.006	0.36	<0.74	7.0	5.9	39.2	0.48
02	F	16	0.473	1.034	0.55	7.8	84	90	318	1.50
03	M	17	0.254	1.024	0.96	4.1	82	84	287	0.73
05	M	17	1.29	1.020	<0.120	5.9	2600*	2450	142	1.84
06	M	15	0.270	1.027	0.75	5.9	252	240	233	0.63
07	M	18	0.587	1.016	0.62	5.5	84	78	193	1.13
08	M	15	1.00	1.014	0.84	<0.74	27	14	134	1.34
09	M	14	0.721	1.016	0.57	3.7	50	47	115	0.83
10	M	17	0.583	1.025	1.30	4.4	260	249	209	1.22
11	F	17	1.53	1.014	0.39	1.8	74	86	94.0	1.44
12	F	17	0.270	1.005	0.41	3.7	14	13.4	54.2	0.15
13	M	15	0.926	1.033	0.28	<0.74	68	60	111	1.03
14	M	16	0.559	1.025	0.38	2.2	14	15	278	1.55
16	F	17	0.358	1.032	0.85	7.4	62	66	246	0.88
17	M	61	1.54	1.002	0.41	4.4	15.4	12.7	14.1	0.22
18	F	16	1.04	1.015	0.66	6.3	<5	<5	71.5	0.75
19	M	17	0.676	1.024	0.47	5.5	96	90	156	1.05
20	M	14	0.180	1.027	0.46	<0.74			--	--
22	F	17	1.48	1.032	0.15	6.7	46	45	123	1.82
23	F	15	0.409	1.028	0.68	14.6	35	37	199	0.82
24	M	18	0.374	1.025	1.26	33.5	290	280	260	0.97
25	F	15	0.488	1.025	0.40	4.3	120	135	179	0.87
26	M	15	0.263	1.019	0.19	0.8	78	90	172	0.45
28	M	18	0.484	1.017	0.79	4.3	50	70	143	0.69
29	F	16	0.414	1.026	0.45	5.5	4.0	1.9	211	0.87
30	F	16	0.767	1.018	0.17	3.9	18	23	66.1	0.51
31	M	13	0.869	1.012	0.34	10.6	248	300	91.2	0.79
32	M	17	0.450	1.020	<0.020	<0.74	47	47	125	0.56
33	F	18	0.980	1.014	0.19	3.1	78	74	42.1	0.41
34	F	12	0.220	1.028	0.86	15.7	135	150	---	---
35	F	17	0.309	1.033	0.83	3.9	40	43	146	0.45
36	F	17	1.66	1.018	0.56	6.7	56	74	70.8	1.18
38	F	15	1.08	1.015	0.60	5.9	96	96	138	1.48
39	M	16	0.836	1.027	0.29	3.1	27	28	191	1.60
40	F	17	0.317	1.016	0.39	5.5	30	34	85.5	0.27
41	F	15	0.751	1.036	<0.120	7.6	45	44	239	1.80
42	F	17	0.258	1.032	0.37	3.7	168	148	168	0.43
43	F	59	1.42	1.010	0.99	2.4	158	158	94.8	1.35
45	F	16	0.205	1.028	1.05	8.5	184	180	194	0.40
47	M	84	1.14	1.017	0.82	5.9	52	47	136	1.55
48	F	18	0.768	1.021	0.50	5.0	36	37	142	1.09
49	M	17	0.418	1.025	0.60	11.9	98	110	167	0.70
50	M	18	1.09	1.037	0.97	21.5	450	380	258	2.81
51	F	18	0.829	1.023	0.52	1.5	31	31	146	1.21
52	F	18	0.432	1.020	0.20	<0.74	48	42	86.7	0.37
53	M	15	0.848	1.021	0.45	7.6	168	148	67.2	0.57
54	M	59	1.25	1.016	0.49	5.4	130	104	143	1.79
56	M	18	0.530	1.025	0.19	13.7	76	58	168	0.89
57	M	15	0.377	1.032	0.53	2.4	27	33	205	0.78
58	M	14	0.179	1.024	0.20	2.8			---	---
59	M	15	0.354	1.021	0.68	2.0	132	161	201	0.71
60	M	58	0.925	1.017	1.76	5.9	<5	<5	119	1.10
61	M	17	0.261	1.039	0.53	1.5	370	310	296	0.77
62	M	17	0.808	1.025	0.28	2.0	56	52	191	1.55
63	M	18	0.402	1.032	0.95	<0.74	44	52	322	1.29
65	F	17	0.395	1.030	<0.120	<0.74	33	33	173	0.68

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TABLE G-1. (CONT'D)

Participant ID	Sex	Age	Volume L	Specific gravity	Cd ug/L	Pb ug/L	Beta$_2$-microglobulin ug/da		Creatinine mg/dL	Creatinine g/da
66	F	18	0.218	1.032	0.84	4.6	6	6.4	281	0.61
67	F	63	0.464	1.017	0.26	1.0	86	110	106	0.49
68	F	14	0.844	1.009	0.22	<0.74	7	6.8	88.4	0.75
69	M	18	0.948	1.022	0.26	1.0	5.2	5.6	150	1.42
70	M	56	0.814	1.023	2.28	5.6	150	148	124	1.01
71	F	52	0.696	1.018	0.35	1.5	14	9	138	0.96
72	F	56	0.750	1.026	0.047	<0.74	106	140	66.4	0.50
75	F	84	1.11	1.022	<0.120	<0.74	40	44	70.2	0.78
76	M	13	0.358	1.014	0.18	<0.74	96	100	134	0.48
77	M	63	1.29	1.021	1.62	4.0	220	200	157	2.03
79	M	66	0.399	1.034	1.95	<0.74	140	138	148	0.59
82	F	50	0.458	1.024	0.33	2.8	38	50	82.6	0.38
83	F	72	1.42	1.030	0.21	<0.74	108	118	56.3	0.80
84	F	51	1.85	1.009	0.34	1.4	76	86	21.3	0.39
85	M	71	1.14	1.017	0.47	6.1	33	33	121	1.38
86	F	59	0.794	1.019	1.29	10.3	38	26	126	1.00
87	F	71	0.581	1.020	1.16	4.2	23	21.5	112	0.65
88	M	77	0.669	1.016	0.79	0.9	48	45	122	0.82
89	M	18	0.360	1.030	0.60	15.0	56	72	221	0.79
90	M	69	1.02	1.010	0.79	10.8	32	26	79.9	0.82
91	F	69	0.429	1.027	0.50	7.0	37	38	196	0.84
92	M	54	1.55	1.032	0.72	<0.74	130	118	144	2.24
93	M	62	1.32	1.034	<0.120	3.8	105	118	72.7	0.96
94	M	58	0.688	1.016	0.17	3.3	440	470	89.7	0.62
96	F	56	0.737	1.031	1.12	8.0	<5	<5	159	1.17
97	F	61	0.256	1.020	1.08	5.6	220	200	141	0.36
98	M	64	1.66	1.013	0.14	5.6	8.2	5.0	67.9	1.13
99	F	58	1.31	1.010	<0.120	<0.74	40	30	28.3	0.37
100	F	57	1.36	1.008	0.21	<0.74	68	76	62.3	0.85
101	F	60	1.23	1.022	0.77	<0.74	180	160	88.2	1.09
102	M	74	0.520	1.014	1.58	4.4	120	140	68.9	0.36
103	F	64	0.191	1.020	1.25	1.8	140	120	118	0.23
104	F	60	0.981	1.013	0.66	<0.74	9.6	9.4	40.9	0.40
105	M	51	0.787	1.016	2.02	9.9	240	230	157	1.23
106	M	65	0.519	1.017	0.42	<0.74	46.5	43.5	50.6	0.26
107	M	14	0.754	1.022	0.44	<0.74	205	200	125	0.95
108	F	53	1.71	1.009	0.42	<0.74	190	174	48.1	0.82
109	F	58	1.75	1.011	0.48	<0.74	10	6.6	55.3	0.97
110	F	50	0.869	1.028	0.74	<0.74	110	115	164	1.43
111	F	18	0.497	1.026	0.63	<0.74	60	51	200	0.99
112	M	13	0.728	1.013	0.70	2.6	14	20	39.6	0.29
113	M	15	0.537	1.015	0.64	<0.74	86	80	98.1	0.53
114	M	67	1.49	1.022	1.21	2.6	88	88	88.1	1.32
115	F	50	1.36	1.012	0.80	1.5	7.8	7.4	109	1.49
116	M	12	0.308	1.024	0.91	13.2	150	176	179	0.55
117	M	77	1.19	1.016	0.49	<0.74	465	435	85.5	1.02
118	M	15	0.893	1.001	0.69	<0.74	160	160	23.3	0.21
119	F	67	0.485	1.024	0.16	<0.74	450	500	183	0.88
120	M	64	0.764	1.023	<0.120	<0.74	218	220	66.1	0.51
122	M	59	1.30	1.011	0.23	4.3	6.8	6.0	96.0	1.25
124	F	50	0.438	1.006	0.23	<0.74	166	157	37.1	0.16
125	F	50	0.754	1.021	2.30	9.0	88	100	137	1.03
126	M	64	1.43	1.006	0.68	3.8	342	356	58.7	0.84
127	M	14	0.295	1.027	<0.120	1.9	450	460	184	0.54
128	M	51	1.43	1.024	1.35	29.0	223	27	151	2.17
129	M	64	1.04	1.023	0.54	2.4	210	210	93.5	0.97

continued...

EPA-287 (Cin.)
(4-76)

TABLE G-1. (CONT'D)

Participant ID	Sex	Age	Volume L	Specific gravity	Cd ug/L	Pb ug/L	Beta2-microglobulin ug/da		Creatinine mg/dL	Creatinine g/da
130	F	50	0.737	1.021	0.48	4.8	220	240	124	0.92
132	F	63	1.02	1.007	0.60	<0.74	520	490	47.1	0.48
133	M	16	0.074	1.024	0.50	1.9	--	--	--	--
134	M	52	0.914	1.025	0.68	9.5	310	360	173	1.58
135	M	68	0.099	1.024	2.05	10.5	--	--	--	--
136	F	17	0.588	1.023	0.15	<0.74	37	48	140	0.82
137	F	18	0.658	1.018	0.48	<0.74	100	98	91.2	0.60
138	M	53	1.14	1.003	0.88	25.7	200	200	41.8	0.47
139	F	54	1.47	1.012	0.53	2.4	210	213	73.5	1.08
140	F	78	0.357	1.022	0.99	6.7	350	420	154	0.55
141	F	59	1.07	1.007	0.67	<0.74	120**	135	64.0	0.69
142	M	63	1.21	1.011	1.16	1.4	106**	118	88.3	1.07
143	M	59	1.77	1.019	0.57	7.1	310**	300	114	2.01
144	M	51	1.71	1.010	0.33	<0.74	290**	270	76.7	1.31
201	M	66	0.864	1.025	1.11	0.9	<5	<5	156	1.35
202	F	70	1.42	1.028	0.86	<0.74	<5	<5	50.8	0.72
203	F	58	1.78	1.020	0.68	6.6	72	50	50.2	0.89
204	F	56	1.07	1.019	1.44	6.6	72	70	103	1.10
205	M	77	0.969	1.010	0.68	52.5	159	159	55.2	0.54
206	F	16	1.19	1.019	0.47	15.4	<5	<5	116	1.38
207	F	64	1.08	1.016	0.80	9.1	53	66	90.7	0.98
208	F	69	1.94	1.024	0.88	<0.74	<5	<5	125	2.43
209	M	12	0.294	1.027	0.86	4.1	56	58	155	0.46
210	F	15	1.28	1.017	0.46	6.0	24	36	72.4	0.93
211	F	14	1.07	1.015	0.88	92.7	47	52	109	1.16
212	M	13	1.08	1.017	0.51	2.2	56	46	63.3	0.69
213	M	17	0.741	1.026	1.34	7.2	88	96	10.4	0.08
214	M	55	0.896	1.021	0.60	2.2	45	42	114	1.02
215	F	12	1.91	1.011	0.55	7.2	91	120	30.9	0.59
216	M	71	0.919	1.011	1.33	10.4	<5	<5	41.1	0.38
217	M	13	1.49	1.023	0.46	12.3	180	160	102	1.52
218	F	17	1.45	1.017	0.60	31.1	34	40	93.2	1.35
219	F	15	0.541	1.021	0.47	3.5	45	43	176	0.95
221	F	18	0.926	1.015	<0.120	2.7	148	148	68.5	0.63
222	M	16	1.06	1.019	0.27	12.6	44	47	141	1.48
223	F	18	1.44	1.017	<0.120	2.2	94	100	153	2.20
224	F	52	1.38	1.013	1.01	2.2	37	35	58.9	0.81
225	M	50	1.82	1.037	<0.120	2.0	35	44	35.6	0.65
226	F	14	1.24	1.011	<0.120	<0.74	92	92	93.9	1.17
227	F	59	1.81	1.018	<0.120	3.3	178	170	7.9	0.14
228	F	16	1.15	1.019	0.29	<0.74	<5	<5	98.9	1.14
229	M	73	0.863	1.018	0.40	12.1	<5	<5	92.5	0.80
230	M	57	1.02	1.022	0.88	5.5	200	230	148	1.64
231	M	12	1.74	1.014	<0.120	<0.74	56	47	36.4	0.63
232	M	61	1.56	1.013	0.65	7.7	<5	<5	62.7	0.98
233	M	56	1.53	1.016	0.61	1.6	<5	<5	107	1.63
234	M	51	1.44	1.022	<0.120	11.5	41	35	157	2.26
235	F	16	1.13	1.012	0.18	4.4	38	37	131	1.48
236	M	12	0.771	1.015	0.18	32.7	160	153	78.4	0.61
237	F	18	0.894	1.018	0.19	0.5	<5	<5	75.3	0.67
238	F	16	0.959	1.016	<0.120	1.6	<5	<5	157	1.51
239	F	56	1.13	1.015	0.73	1.1	<5	<5	100	1.13
240	M	67	0.379	1.021	<0.120	10.4	<5	<5	198	0.75
241	M	14	0.272	1.026	0.68	12.8	150	180	206	0.56
242	F	58	0.761	1.019	0.76	7.9	<5	<5	144	1.10
243	M	14	1.08	1.030	0.26	17	47	36	137	1.48

continued...

BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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EPA-287 (Cin.)
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TABLE G-1. (CONT'D)

Participant			Volume	Specific	Cd	Pb	Beta$_2$-microglobulin		Creatinine	
ID	Sex	Age	L	gravity	ug/L	ug/L	ug/da		mg/dL	g/da
244	F	80	0.545	1.019	0.57	69.5	98	86	35.3	0.19
245	F	17	0.505	1.021	0.15	5.6	46	43	103	0.52
246	F	17	1.85	1.017	0.18	1.1	44	47	82.6	1.53
247	M	14	1.54	1.016	0.43	3.8	180	220	173	2.66
248	F	74	1.39	1.015	0.48	6.8	54	38	43.2	0.60
249	F	83	0.791	1.013	0.96	4.7	84	54	79.0	0.63
250	F	83	1.28	1.013	0.13	6.1	233	220	18.6	0.24
251	M	17	1.58	1.022	0.15	5.2	100	132	81.4	1.29
252	M	60	0.696	1.008	0.41	8.8	38	47	32.6	0.23
253	M	14	1.45	1.026	0.26	9.2	<5	<5	182	2.64
254	F	14	0.318	1.004	0.88	4.3	<5	<5	13.7	0.04
255	M	15	1.05	1.022	0.43	9.7	104	98	121	1.28
256	M	12	0.868	1.017	0.26	11	31	34	118	1.03
258	F	14	1.48	1.006	<0.120	2.0	<5	<5	9.30	0.14
259	F	17	0.437	1.016	<0.120	2.0	60	78	37.6	0.16
260	F	16	1.65	1.019	0.35	2.5	190	190	9.80	0.16
261	F	51	1.31	1.015	0.23	1.5	56	54	101	1.32
262	M	18	1.65	1.017	0.35	4.0	34	36	248	4.07
263	F	54	1.28	1.017	0.64	5.7	57	57	94.9	1.21
264	M	78	1.18	1.016	0.51	2.8	158	160	32.1	0.38
265	F	14	0.832	1.011	0.48	6.2	45	36	85.8	0.72
266	M	17	1.76	1.010	0.13	2.8	33	36	114	2.00
267	F	69	0.853	1.018	0.49	1.1	<5	<5	75.8	0.65
268	M	52	1.31	1.008	0.133	<0.74	133	128	15.4	0.20
269	F	16	0.694	1.020	0.51	<0.74	45	40	107	0.75
270	F	73	0.918	1.019	0.55	9.6	72	72	56.3	0.99
271	F	16	0.377	1.014	0.16	3.6	<5	<5	18.9	0.07
272	F	14	0.352	1.020	0.24	9.2	130	140	92.8	0.33
273	M	84	1.10	1.012	0.25	4.5	143	165	150	1.65
274	M	75	1.14	1.022	0.44	25.8	470	470	137	1.57
275	F	12	1.84	1.018	<0.120	7.5	<5	<5	83.2	1.53
276	F	13	1.52	1.016	0.17	9.6	58	63	78.3	1.19
277	M	80	0.509	1.022	<0.120	24.9	608	606	123	0.62
278	F	70	1.61	1.020	0.44	30.0	137	137	11.1	0.18
279	M	76	1.44	1.016	<0.120	8.7	135	126	118	1.69
280	F	50	0.783	1.020	<0.120	13.4	33	36	118	0.93
281	M	15	1.85	1.021	0.24	9.5	98	98	135	2.50
282	M	12	1.02	1.018	0.21	9.9	120	115	141	1.44
283	F	16	1.10	1.021	0.23	2.2	<5	<5	53.2	0.59
284	F	15	1.17	1.022	0.33	8.7	72	74	127	1.49
285	M	17	1.24	1.010	0.18	1.0	200	200	11.6	0.14
286	M	12	0.535	1.027	0.16	3.9	44	46	93.4	0.50
287	M	13	0.838	1.024	0.25	3.4	174	174	154	1.29
288	M	13	1.07	1.016	0.33	3.0	180	160	45.8	0.49
289	M	13	0.968	1.018	0.67	4.7	38	33	65.0	0.63
290	F	60	1.46	1.009	0.67	<0.74	170	150	151	2.22
291	F	63	1.30	1.011	0.57	3.4	32	32	91.1	1.18
292	M	14	1.07	1.009	0.18	1.4	107	107	47.9	0.51
293	F	16	1.07	1.013	0.26	4.7	32	34	79.2	0.85
294	M	15	1.84	1.013	0.39	3.4	<5	<5	58.7	1.08
295	M	14	1.66	1.022	0.38	5.1	<5	<5	85.3	1.42
296	F	14	1.29	1.018	0.11	7.5	<5	<5	21.2	0.27
297	M	13	0.941	1.020	0.23	6.3	52	48	92.2	0.87
298	F	71	1.69	1.008	0.77	<0.74	840	720	7.40	0.13
299	F	58	0.622	1.029	0.54	4.3	<5	<5	57.4	0.36

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BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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EPA-287 (Cin.)
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TABLE G-1. (CONT'D)

Participant			Volume	Specific	Cd	Pb	Beta$_2$-microglobulin		Creatinine	
ID	Sex	Age	L	gravity	ug/L	ug/L	ug/da		mg/dL	g/da
300	M	58	1.83	1.006	0.45	<0.74	68	60	34.2	0.63
301	M	14	0.783	1.022	0.39	4.5	<5	<5	121	0.95
302	F	51	1.46	1.021	<0.120	5.6	230	212	87.6	1.28
303	F	16	0.644	1.015	0.52	4.5	120	132	50.8	0.33
304	F	14	0.988	1.014	0.31	3.7	32	34	24.6	0.24
305	M	51	1.75	1.020	0.42	5.2	<5	<5	120	2.10
306	M	56	1.62	1.006	0.80	6.0	120	80	53.5	0.87
307	M	57	1.19	1.006	0.27	1.7	86	110	7.90	0.09
308	M	59	1.84	1.013	0.70	4.5	52	52	44.7	0.82
309	F	58	1.88	1.014	1.11	9.9	<5	<5	74.2	1.39
310	F	17	1.29	1.021	0.35	4.5	100	78	61.6	0.80
311	M	68	0.641	1.024	0.33	14.2	62	62	70.0	0.45
312	F	12	1.53	1.023	0.20	4.5	50	52	116	1.78
313	M	86	0.959	1.018	0.25	6.4	38	48	76.2	0.73
314	M	64	1.43	1.015	0.70	10.3	68	52	38.0	0.54
315	M	18	0.476	1.032	0.66	12.6	<5	<5	346	1.65
316	M	16	0.695	1.017	0.21	2.1	<5	<5	61.1	0.42
317	F	13	0.685	1.017	0.32	8.7	52	42	123	0.84
318	F	50	1.91	1.010	0.67	1.7	<5	<5	76.3	1.46
319	M	53	1.38	1.011	0.72	5.2	<5	<5	62.1	0.86
320	M	63	0.320	1.025	0.47	10.7	150	220	111	0.36
321	F	15	1.32	1.011	0.58	6.4	50	71	36.8	0.49
322	F	18	0.771	1.019	0.68	4.6	64	78	156	1.21
324	F	51	1.09	1.017	0.68	4.9	110	110	29.5	0.32
325	M	18	1.53	1.022	0.93	8.6	58	47	232	3.55
326	M	17	1.44	1.013	0.35	6.8	220	212	194	2.79
327	F	78	1.23	1.018	1.07	3.8	140	120	45.3	0.56
328	M	73	1.81	1.014	0.36	1.3	<5	<5	62.6	1.14
329	F	12	1.01	1.028	0.16	3.1	47	44	162	1.63
330	M	12	1.50	1.023	<0.120	8.6	36	38	16.1	0.24
331	M	15	1.09	1.017	0.15	5.7	<5	<5	65.8	0.72
332	F	15	1.87	1.026	0.28	4.2	45	34	129	2.41
333	F	69	0.737	1.020	1.70	9.7	<5	<5	136	1.00
334	M	18	1.13	1.024	0.20	3.5	<5	<5	83.7	0.95
335	F	65	1.67	1.019	1.33	4.6	<5	<5	50.5	0.84
336	M	15	0.688	1.025	0.20	4.9	270	340	35.4	0.24
337	M	68	1.68	1.011	0.19	7.8	45	56	42.2	0.71
338	F	77	1.93	1.010	0.28	0.9	230	220	16.5	0.32
339	F	15	1.46	1.018	0.32	7.5	<5	<5	66.0	0.97
340	M	66	1.60	1.016	0.45	2.7	<5	<5	101	1.62

* Test repeated.

** Urine samples spun prior to freezing.

Detection Limit: <0.120 for Cd; <0.74 for Pb.

EPA-287 (Cin.)
(4-76)

TABLE G-2. ANALYSIS OF BLOOD SAMPLES

Participant			Whole blood			Hemoglobin		Blood serum (ug/dL)			
			Cd	Pb	Fe			Fe		TIBC	
ID	Sex	Age	ug/dL	ug/dL	mg/dL	g/dL	g/dL				
01	F	17	N/S	N/S	N/S						
02	F	16	0.239	3.37	46.0	13.1		70		391	
03	M	17	0.436	5.67	57.2	17.8	17.5	169		394	
05	M	17	0.254	10.8	30.4	15.0		98		334	
06	M	15	0.406	10.8	52.8	16.0		133		342	
07	M	18	0.202	7.80	54.0	15.9		155		422	
08	M	15	0.171	7.27	51.6	15.5		169		352	
09	M	14	0.277	33.5	48.4	14.7		145		334	
10	M	17	0.171	6.21	48.4	14.4		126		182	
11	F	17	0.277	4.43	50.0	15.1	14.5	91		430	
12	F	17	0.428	3.55	47.0	15.2		108		334	
13	M	15	0.753	5.32	34.6	13.4	12.5	69	42	281	269
14	M	16	0.202	3.72	43.6	14.7		239		439	
16	F	17	0.111	<0.780	44.2	13.5	12.7	132		318	
17	M	61	<0.072	7.45	48.4	17.0	17.8	91	117	279	290
18	F	16	0.088	7.62	47.0	13.2		89		334	
19	M	17	0.186	11.3	54.0	18.1		158		374	
20	M	14	0.164	5.14	51.6	15.3		56		334	
22	F	17	0.106	5.02	63.6	15.1	15.5	138		412	
23	F	15	0.156	8.91	46.4	14.0		56		329	
24	M	18	0.092	5.35	45.2	16.8				360+	
25	F	15	<0.072	2.27	46.0	13.9		42		309	
26	M	15	<0.072	5.67	51.6	15.5		169		401	
28	M	18	0.135	8.26	55.2	15.0	15.9	90	91	356	377
29	F	16	0.142	4.38	39.4	12.9	12.7	76	86	365	378
30	F	16	0.191	1.78	40.8	12.1		71		496	
31	M	13	0.170	11.0	48.2	17.0		123		307	
32	M	17	0.113	16.2	45.8	14.8		98		345	
33	F	18	0.227	4.54	45.2	13.8	13.3	42	49	269	293
34	F	12	<0.072	4.05	45.0	13.5		105		461	
35	F	17	<0.072	1.46	44.4	13.8	13.7	56		348	
36	F	17	<0.072	1.62	43.0	13.0	13.5	176	119	414	369
38	F	15	0.163	2.43	46.4	13.8		85		368	
39	M	16	0.191	5.35	50.8	15.3		70		314	
40	F	17	<0.072	8.10	35.4	10.6		33		423	
41	F	15	N/S	N/S	N/S			--		--	
42	F	17	0.293	1.78	43.8	15.2		228		463	
43	F	59	0.181	4.16	47.4	14.8		202		430	
45	F	16	0.118	13.4	38.6	11.7		141		408	
47	M	84	0.167	8.77	50.2	14.3		105		325	
48	F	18	0.084	4.31	45.4	13.4		191		441	
49	M	17	0.091	12.2	52.4	16.3		154		346	
50	M	18	<0.072	3.57	48.8	14.7		42		259	
51	F	18	0.091	1.34	45.0	13.4		125		336	
52	F	18	0.272	16.4	40.8	14.6		40		378	
53	M	15	0.195	5.50	43.0	13.6		158		539	
54	M	59	0.125	4.01	51.2	16.2		126		290	
56	M	18	<0.072	3.42	54.0	15.3		146		313	
57	M	15	0.181	9.22	48.0	14.9		112		378	
58	M	14	N/S	N/S	N/S			--		--	
59	M	15	0.327	8.92	43.2	14.0		74		303	
60	M	58	0.307	13.5	60.2	17.4	17.6	104	109	368	357
61	M	17	0.128	7.25	53.2	16.6		136		400	
62	M	17	1.61	13.8	49.2	16.3		141		391	
63	M	18	1.05	7.59	57.2	17.8		84		310	
65	F	17	N/S	N/S	N/S			--		--	

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(4-76)

TABLE G-2. (CONT'D)

Participant			Whole blood			Hemoglobin		Blood serum (ug/dL)			
ID	Sex	Age	Cd ug/dL	Pb ug/dL	Fe mg/dL	g/dL	g/dL	Fe		TIBC	
66	F	18	0.273	6.58	42.6	13.5		111		371	
67	F	63	<0.072	5.90	46.2	14.2	14.3	98		329	
68	F	14	N/S	N/S	N/S			--		--	
69	M	18	0.196	6.24	49.2	16.1	15.5	84	218	334	433
70	M	56	0.162	12.0	49.0	15.0		125		338	
71	F	52	0.094	6.58	46.4	18.3		89		348	
72	F	56	<0.072	1.18	43.4	13.2		125		302	
75	F	84	0.256	3.20	46.0	14.5		96		398	
76	M	13	0.461	7.59	46.1	15.6		173		341	
77	M	63	0.290	14.8	51.2			113		345	
79	M	66	0.265	16.7	47.6	15.5		170		347	
82	F	50	0.248	11.2	50.6	15.0	14.8	95	97	288	297
83	F	72	<0.072	<0.780	47.4	16.1	16.6	87	102	260	252
84	F	51	0.213	3.84	52.0	14.3		87		342	
85	M	71	<0.072	5.16	45.2	13.7	13.8	130	104	343	261
86	F	59	0.359	18.3	49.8	14.5		73		332	
87	F	71	0.726	51.6	46.2	13.6		65		265	
88	M	77	0.265	8.26	42.4	12.5		97		260	
89	M	18	0.145	13.1	50.2	16.3		176		346	
90	M	69	2.48	20.4	50.2	16.1	16.0	132		313	
91	F	69	0.085	18.6	47.4	16.1		135		316	
92	M	54	0.102	4.57	57.0	17.0		110		312	
93	M	62	<0.072	9.30	49.6	18.1		107		326	
94	M	58	<0.072	7.53	43.8	13.0		4		322	
96	F	56	0.145	2.21	45.8	14.8	15.2	92		332	
97	F	61	0.111	6.64	48.4	15.1		206		453	
98	M	64	<0.072	11.1	39.8	12.7		71		397	
99	F	58	<0.072	9.00	42.0	12.2		123		368	
100	F	57	0.563	3.10	47.8	13.6		82		382	
101	F	60	0.154	6.44	45.4	14.4	14.5	113	114	354	329
102	M	74	0.128	8.95	42.0	13.3	13.8	78	99	272	258
103	F	64	0.102	2.20	50.4	14.8	14.8	64		266	
104	F	60	0.137	4.40	40.8	12.6		80		333	
105	M	51	0.154	7.69	53.2	13.5	13.7	205	202	328	299
106	M	65	0.172	7.38	46.8	15.2	14.8	113		364	
107	M	14	0.110	5.18	48.4	16.1		173		486	
108	F	53	0.578	6.12	38.0	13.9	14.0	94	100	315	333
109	F	58	0.119	5.49	33.6	14.0	13.8	100		274	
110	F	50	0.128	4.87	39.0	11.6		68		473	
111	F	18	<0.072	13.7	37.4	15.0		93		398	
112	M	13	0.154	11.3	43.0	14.2		181		464	
113	M	15	0.305	10.8	50.8	14.6		149		341	
114	M	67	0.163	9.42	58.4	19.2		154		360	
115	F	50	0.154	10.5	49.4	15.3		155		320	
116	M	12	<0.072	11.1	32.8	13.2		270		394	
117	M	77	0.075	10.8	54.2	17.4	17.1	136	153	400	625
118	M	15	0.260	12.6	60.2	16.9		254		453	
119	F	67	0.110	4.71	41.6	13.5	13.4	103		301	
120	M	64	<0.072	14.0	54.2	17.2	17.5	142	138	289	332
122	M	59	<0.072	15.7	44.6	--		203		337	
124	F	50	0.084	2.97	29.2	9.7		24		446	
125	F	50	N/S	N/S	N/S			--		--	
126	M	64	0.154	14.1	50.8	15.3		77		241	
127	M	14	0.269	12.8	45.6	13.2		179		259	
128	M	51	0.199	18.0	40.8	13.9		85	94	321	290
129	M	64	0.278	12.7	46.6	15.6	15.2	189	192	292	303

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TABLE G-2. (CONT'D)

Participant			Whole blood			Hemoglobin		Blood serum (ug/dL)			
			Cd	Pb	Fe						
ID	Sex	Age	ug/dL	ug/dL	mg/dL	g/dL	g/dL	Fe		TIBC	
130	F	50	N/S	N/S	N/S			--		--	
132	F	63	0.340	4.23	44.2	14.6	13.5	118	143	310	407
133	M	16	0.287	5.64	50.2	17.5		429			
134	M	52	0.243	8.45	51.8	15.6	15.6	104	105	288	274
135	M	68	<0.072	9.55	55.2	16.7	16.7	56	94	329	358
136	F	17	<0.072	3.60	47.6	13.8		116		374	
137	F	18	<0.072	<0.780	45.2	13.7		42		269	
138	M	53	<0.072	11.9	42.6	13.2		96		281	
139	F	54	<0.072	6.42	45.6	14.2		149		356	
140	F	78	<0.072	3.29	46.6	17.0		147		329	
141	F	59	<0.072	1.41	45.8	13.3		73		326	
142	M	63	<0.072	2.66	50.0	14.7		151		288	
143	M	59	<0.072	6.11	43.4	10.2		103		322	
144	M	51	0.284	5.95	50.2	18.1		60		299	
201	M	66	0.201	17.8	48.0	15.8		*			
202	F	70	0.789	10.5	40.8	13.0		*			
203	F	58	0.604	39.6	47.2	14.0		*			
204	F	56	0.113	15.6	38.6	10.9		*			
205	M	77	0.185	13.8	43.6	13.9		*			
206	F	16	0.161	14.8	39.4	12.7		*			
207	F	64	0.346	15.0	40.8	13.2		*			
208	F	69	0.177	9.52	43.4	13.6		*			
209	M	12	0.145	12.5	53.0	13.4		*			
210	F	15	1.022	14.6	39.8	12.0		*			
211	F	14	0.250	11.3	38.4	12.2		*			
212	M	13	0.362	10.9	38.2	12.6		*			
213	M	17	0.539	16.6	42.2	13.4		*			
214	M	55	0.531	26.0	51.6	15.0		*			
215	F	12	<0.072	9.72	42.2	12.9		*			
216	M	71	0.137	21.1	48.6	17.9		*			
217	M	13	0.097	14.2	34.4	12.5		*			
218	F	17	N/S	N/S	N/S	--					
219	F	15	N/S	N/S	N/S	--					
221	F	18	0.105	15.5	42.0	11.9		*			
222	M	16	0.209	13.0	46.6	15.3		*			
223	F	18	<0.072	12.2	45.4	14.8		*			
224	F	52	2.90	13.8	44.0	12.6		*			
225	M	50	0.129	19.2	54.2	16.5		*			
226	F	14	0.145	12.9	40.6	11.8		*			
227	F	59	N/S	N/S	N/S	--					
228	F	16	0.105	18.6	46.4	13.7		*			
229	M	73	0.072	19.2	52.8	15.0		*			
230	M	57	0.097	12.7	51.4	15.4		*			
231	M	12	0.185	13.4	43.8	12.9		*			
232	M	61	0.177	16.2	52.6	15.9		*			
233	M	56	0.097	41.0	52.4	15.6		*			
234	M	51	0.169	20.1	55.0	16.1		*			
235	F	16	<0.072	10.6	39.4	12.0		*			
236	M	12	<0.072	19.0	38.6	13.0		*			
237	F	18	<0.072	9.50	40.0	12.6		*			
238	F	16	0.258	14.7	43.2	12.9		*			
239	F	56	0.129	10.2	52.0	11.9		*			
240	M	67	0.129	14.0	45.4	15.7		*			
241	M	14	<0.072	12.0	38.2	11.7		*			
242	F	58	<0.072	10.1	38.2	13.2		*			
243	M	14	<0.072	8.25	45.6	15.5		*			

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BOTTOM OF IMAGE AREA: OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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TABLE G-2. (CONT'D)

Participant			Whole blood					Blood serum (ug/dL)	
			Cd	Pb	Fe	Hemoglobin			
ID	Sex	Age	ug/dL	ug/dL	mg/dL	g/dL	g/dL	Fe	TIBC
244	F	80	0.354	15.4	43.6	13.4		*	
245	F	17	<0.072	2.25	39.6	11.6		*	
246	F	17	0.076	6.37	40.0	11.4		*	
247	M	14	<0.072	4.12	47.6	14.3		*	
248	F	74	0.250	7.87	38.2	11.7		*	
249	F	83	<0.072	5.06	41.4	12.6		*	
250	F	83	0.076	12.2	46.2	13.4		*	
251	M	17	0.097	6.94	48.8	14.5		*	
252	M	60	0.153	15.4	47.2	14.1		*	
253	M	14	<0.072	9.19	47.6	13.9		*	
254	F	14	<0.072	5.06	46.0	14.0		*	
255	M	15	<0.072	12.9	39.6	12.8		*	
256	M	12	<0.072	12.4	48.6	13.0		*	
258	F	14	<0.072	6.75	41.8	11.8		*	
259	F	17	0.076	4.12	38.0	11.3		*	
260	F	16	0.215	2.63	49.4	13.4		*	
261	F	51	0.090	5.52	50.6	13.9		*	
262	M	18	0.083	6.06	51.6	14.9		*	
263	F	54	0.229	13.2	49.8	14.5		*	
264	M	78	0.194	11.0	51.2	14.8		*	
265	F	14	<0.072	4.81	47.4	13.8		*	
266	M	17	<0.072	7.84	49.6	14.9		*	
267	F	69	0.076	5.52	46.4	13.8		*	
268	M	52	0.090	11.8	50.0	14.9		*	
269	F	16	<0.072	11.8	46.4	13.0		*	
270	F	73	<0.072	16.9	47.0	13.4		*	
271	F	16	<0.072	4.10	43.4	12.1		*	
272	F	14	<0.072	3.56	44.8	12.8		*	
273	M	84	0.118	9.80	52.0	14.3		*	
274	M	75	0.132	17.6	44.6	12.7		*	
275	F	12	<0.072	11.6	47.4	12.4		*	
276	F	13	<0.072	6.59	40.8	12.0		*	
277	M	80	0.222	18.3	49.6	14.4		*	
278	F	70	<0.072	2.14	48.0	13.6		*	
279	M	76	<0.072	7.66	49.8	14.0		*	
280	F	50	0.118	6.06	30.6	8.8		*	
281	M	15	<0.072	9.89	40.8	13.2		*	
282	M	12	<0.072	14.2	43.6	12.8		*	
283	F	16	<0.072	4.67	47.0	13.2		*	
284	F	15	<0.072	4.49	45.4	13.0		*	
285	M	17	0.353	5.21	46.2	13.8		*	
286	M	12	0.359	6.29	46.6	13.7		*	
287	M	13	<0.072	5.93	51.6	13.6		*	
288	M	13	<0.072	7.55	51.4	14.5		*	
289	M	13	<0.072	13.5	49.4	13.8		*	
290	F	60	N/S	N/S	N/S	--			
291	F	63	0.075	6.47	56.4	16.1		*	
292	M	14	0.274	7.55	52.4	15.4		*	
293	F	16	<0.072	3.78	41.4	11.8		*	
294	M	15	<0.072	6.83	43.0	12.8		*	
295	M	14	0.093	9.89	51.4	14.1		*	
296	F	14	0.087	10.8	43.4	12.5		*	
297	M	13	<0.072	10.6	43.0	11.9		*	
298	F	71	<0.072	8.27	49.0	14.3		*	
299	F	58	<0.072	6.83	48.4	13.4		*	

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TABLE G-2. (CONT'D)

Participant			Whole blood			Hemoglobin		Blood serum (ug/dL)	
			Cd	Pb	Fe				
ID	Sex	Age	ug/dL	ug/dL	mg/dL	g/dL	g/dL	Fe	TIBC
300	M	58	0.347	16.5	48.8	13.6		*	
301	M	14	0.184	7.45	43.2	12.0		*	
302	F	51	<0.072	2.25	50.6	14.2		*	
303	F	16	0.359	9.19	44.8	12.6		*	
304	F	14	<0.072	3.81	49.6	14.1		*	
305	M	51	<0.072	16.1	51.0	15.0		*	
306	M	56	N/S	N/S	N/S	—			
307	M	57	2.295	8.49	51.6	14.7		*	
308	M	59	0.232	12.8	54.4	15.7		*	
309	F	58	<0.072	4.68	46.6	13.4		*	
310	F	17	<0.072	2.08	37.2	10.9		*	
311	M	68	<0.072	10.9	51.4	15.1		*	
312	F	12	<0.072	2.77	44.4	13.6		*	
313	M	86	<0.072	11.3	50.8	14.7		*	
314	M	64	1.170	21.5	45.0	12.8		*	
315	M	18	<0.072	10.7	49.8	14.5		*	
316	M	16	<0.072	7.45	56.0	15.8		*	
317	F	13	<0.072	5.03	52.4	13.5		*	
318	F	50	0.099	4.68	49.2	14.4		*	
319	M	53	0.111	15.4	44.6	13.2		*	
320	M	63	<0.072	11.3	50.0	14.8		*	
321	F	15	<0.072	7.00	48.4	14.5		*	
322	F	18	<0.072	3.68	46.2	12.7		*	
324	F	51	0.093	8.05	47.8	13.9		*	
325	M	18	0.111	14.9	55.6	16.0		*	
326	M	17	<0.072	18.7	53.2	14.7		*	
327	F	78	N/S	N/S	47.0	11.4		*	
328	M	73	<0.072	7.18	50.8	15.4		*	
329	F	12	<0.072	6.13	44.2	12.4		*	
330	M	12	<0.072	7.53	47.0	13.1		*	
331	M	15	<0.072	3.85	51.2	15.1		*	
332	F	15	<0.072	6.30	46.8	13.5		*	
333	F	69	<0.072	41.3	47.6	13.7		*	
334	M	18	<0.072	5.25	57.0	16.7		*	
335	F	65	<0.072	1.05	45.6	13.3		*	
336	M	15	<0.072	4.73	51.4	14.7		*	
337	M	68	<0.072	18.0	47.6	12.9		*	
338	F	77	<0.072	6.48	40.8	13.4		*	
339	F	15	<0.072	8.40	47.4	13.4		*	
340	M	66	<0.072	4.03	43.4	17.0		*	

* Samples not suitable for a wet chemistry Fe analysis.

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(4-76)

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TABLE G-3. ANALYSIS OF 24-HOUR FECES SAMPLES

Participant ID	Sex	Age	Wet weight (g) A	Wet weight (g) B	Cd (mg/g)* A	Cd (mg/g)* A	Cd (mg/g)* B	Cd (mg/g)* B	Pb (µg/g)* A	Pb (µg/g)* A	Pb (µg/g)* B	Pb (µg/g)* B	Zn (µg/g)* A	Zn (µg/g)* B	Ca (mg/g)* A	Ca (mg/g)* A	Ca (mg/g)* B	Ca (mg/g)* B	Fe (µg/g)* A	Fe (µg/g)* A	Fe (µg/g)* B	Fe (µg/g)* B
01	F	17	32.9	31.3	0.522		0.867	0.301	0.740	0.408			276	257	27.5		17.7		754	266		
02	F	16	10.9	17.1	0.660		0.429		1.04	0.909			492	536	25.7	34.2	22.3	19.5	405	249		
03	M	17	53.3	130	0.580	0.576	0.551	0.565	1.32	1.25	1.41	1.44	344	348	22.3	19.5	29.8	19.8	86.9	188	146	103
05	M	17	63.1	79.7	0.613	0.817	0.769	0.801	11.5	9.60	9.76	10.3	827	409	17.5	16.3	15.8	15.8	261	77.9	56.2	71.1
06	M	15	88.2	43.8	0.722		0.394		1.25	0.434			168	218	12.8	25.9	12.1		517	611		
07	M	18	47.0	81.2	0.457	0.499	0.512	0.566	1.40	1.40	1.47	1.78	312	312	26.9	32.1	23.6	26.2	123	125	71.1	71.1
08	M	15	116	107	0.698	0.604	0.680	0.670	1.16	1.12	1.10	1.31	281	545	12.6	10.2	12.0	14.1	331	88.0	316	114
09	M	14	61.4	66.6	0.299		0.211		1.46	1.13			317	416	25.5	38.1	24.7		445	49.2		
10	M	17	60.2	120	0.399	0.480	0.382	0.344	0.607	1.22	0.664	0.606	818	706	39.4	35.4	33.3	31.0	533	147	136	185
11	F	17	38.7	65.9	0.446	0.531	0.575	0.529	0.929	1.08	1.10	1.08	477	527	27.9	30.3	34.8	32.7	168	76.5	90.5	298
12	F	17	70.6	14.0	0.531		0.255		1.51	0.911			428	396	13.8	23.2	13.8		114	83.8		
13	M	15	48.6	82.8	0.987		0.423		1.50	0.998			587	574	27.2	46.6	26.5		721	264		
14	M	16	133	31.3	0.681				0.671	0.407			295	328	13.9	18.0	13.1		452	200		
16	F	17	38.7	51.8	0.778		0.422		1.38	0.940			301	286	20.6	28.3	19.8		68.9	42.7		
17	M	61	21.6	10.0	0.505		0.404		0.50		3.09		151	162	12.8		23.6	26.2	657	275		
18	F	16	21.8	68.9	0.642		0.407		1.72	1.40			301	312	17.5	24.4	16.8		1410	953		
19	M	17	39.5	18.6	1.05		0.496		0.824	0.459			397	372	20.3	32.3	19.5		318	144		
20	M	14	25.6	13.1	0.712		0.428		0.858	0.461			399	399	12.8	19.1	12.0		618	469		
22	F	17	71.4	48.7	0.998		0.451		8.51	6.56			436	408	17.5	35.5	16.7		561	145		
23	F	15	28.7	18.3	0.984		0.431		1.81	1.38			525	457	16.9	32.6	16.1		483	86.9		
24	M	18	143	21.8	0.386		0.225		0.902	0.625			279	279	21.7	32.6	21.0		157	71.7		
25	F	15	18.6	15.8	1.03		0.530		6.43	5.28			453	370	20.5	31.1	19.7		559	351		
26	M	15	54.3	19.6	0.185	0.201	0.479	0.416	0.620	0.704	0.655	0.069	450	414	56.3	58.4	51.6	62.6	120	81.5	191	827
28	M	18								-----No Sample Collected-----												
29	F	16	33.9	50.8	0.241	0.237	0.231	0.178	0.360	0.344	0.568	0.728	206	309	33.9	32.0	42.2	46.5	142	145	485	310
30	F	16	63.3	45.0	0.186	0.256	0.142	0.213	0.304	0.260	0.256	0.288	279	239	31.4	32.6	29.6	27.2	402	400	31.0	52.0
31	M	13	75.1	28.1	0.286	0.286	0.158	0.078	0.942	0.722	0.039	0.726	187	165	23.1	27.7	24.8	8.01	441	112	314	352
32	M	17	104	142	0.132	0.132	0.137	0.176	0.244	0.246	0.379	0.483	264	309	36.4	38.9	42.5	43.3	371	66.0	70.0	71.0
33	F	18	31.9	39.7	0.178	0.141	0.117	0.193	0.671	0.754	0.116	1.03	472	389	45.4	43.7	43.2	29.7	104	456	352	232
34	F	12	49.1	71.6	0.128	0.080	0.257	0.243	0.053	0.466	0.322	0.823	375	695	53.4	17.1	47.5		217	166	663	560
35	F	17	45.0	64.1	0.226	0.213	0.233	0.309	0.155	0.149	0.176		265	360	22.1	22.7	22.9	24.9	179	92.3	150	294
36	F	17	101	113	0.073	0.319	0.122	0.442		0.171	0.208	0.259	250	263	25.6		32.1	17.9	92.3		519	69.2
38	F	15								-----No Sample Collected-----												
39	M	16	159	153	0.109	0.122	0.064	0.066	0.344	0.338	0.193	0.221	194	263	31.3	31.2	31.3	29.7	277	283	265	462
40	F	17	70.6	96.1	0.625	0.591	0.408	0.362	1.54	1.88	0.487	0.031	583	243	27.1	29.2	25.9	31.2	254	323	346	173
41	F	15	20.4	12.5	0.355	0.340	0.270		0.804	0.868	0.695		293	286	26.8	27.2	29.0		213	202	162	
42	F	17	57.2	111	0.343	0.359	0.337	0.126	0.302	0.399	0.204	0.311	426	188	34.2	34.2	27.5	10.7	323	213	80.8	317
43	F	59	263	51.4	0.168	0.187	0.166	0.174	0.421	0.683	0.355	0.454	578	235	17.6	19.6	18.8		301	393	114	145
45	F	16	47.3	47.7	0.068	0.074	0.196	0.198	0.425	0.412	0.661	0.851	594	432	18.2	17.9	13.0	13.1	343	335	234	216
47	M	84	29.6	47.3	0.264	0.281	0.117	0.124	1.64	1.19	0.421	0.468	302	245	24.2	26.2	28.2	28.4	381	413	398	384
48	F	18	83.8	79.4	0.204	0.215	0.167	0.184	9.03	8.11	5.69	5.42	310	383	14.0	13.9	16.1	16.9	212	265	130	166
49	M	17	18.2	23.9	0.352		0.313		1.28	1.34	1.17	1.18	294	320	7.42		10.4		371		424	
50	M	18	124	201	0.386		0.171		1.76		1.06		227	148	9.42		14.1		490		1060	
51	F	18	101	74.9	0.225		0.220		1.34		1.57		250	307	13.2		15.8		410		497	
52	F	18	15.7	42.9	0.235		0.310		2.53		2.34		469	418	13.2		12.8		377		426	
53	M	15	101	61.1	0.336		0.424		4.26		2.18		230	354	13.2		11.8		314		277	
54	M	59	125	96.1	0.234		0.200		0.992		0.864		385	281	20[illegible]		18.7		459		280	

continued...

TABLE G-3. (CONT'D)

Participant			Wet weight (g)		Cd (mg/g)*				Pb (µg/g)*				Zn (µg/g)*		Ca (mg/g)*				Fe (µg/g)*			
ID	Sex	Age	A	B	A	A	B	B	A	A	B	B	A	B	A	A	B	B	A	A	B	B
56	M	18	101	186	0.268		0.560		0.896		1.15		328	267	11.7		17.1		165		217	
57	M	15	115	13.7	0.225		0.200		2.37		2.66		389	404	24.9		23.1		647		499	
58	M	14	44.2	50.4	0.221		0.222		0.928		1.15		341	329	18.0		16.1		323		457	
59	M	15	35.8	17.1	0.174		0.258		1.25		1.15		852	905	20.5		23.4		673		916	
60	M	58	187	184	0.589		0.645		2.45		0.80		144	124	7.84		8.23		215		251	
61	M	17	97.5	70.5	0.203		0.329		0.864		1.73		239	205	16.2		10.6		319		280	
62	M	17	96.8	40.3	0.371		0.284		4.80		2.11		381	334	25.1		27.8		808		498	
63	M	18	41.0	17.1	0.237		0.289		1.34		1.28		476	599	14.3		17.9		633		477	
65	F	17	45.3	37.8	0.336		0.354		3.20		2.94		616	637	23.6		24.7		301		324	
66	F	18			0.619		NSC		0.960		NSC		455	NSC	17.8		NSC		366		NSC	
67	F	63	24.3	115	0.186		0.250		1.60		1.98		503	344	37.6		36.5		367		855	
68	F	14	45.0	22.6	0.227		0.224		0.736		0.768		369	339	23.6		21.9		267		481	
69	M	18	61.4	51.6	0.600		0.601		2.85		2.37		767	723	13.3		14.0		440		143	
70	M	56	119	97.2	0.178		0.174		1.60		1.76		175	186	25.2		26.8		231		191	
71	F	52	38.9	15.8	0.227		0.265		2.56		2.37		291	302	37.8		34.2		333		544	
72	F	56	150	84.9	0.176		0.181		1.57		1.79		995	990	24.1		24.4		412		518	
75	F	84	58.9	48.4	0.151		0.170		3.55		5.92		203	206	20.7		19.6		143		289	
76	M	13	54.2	51.6	0.470		0.459		1.00		0.60		260	255	17.4		18.2		250		249	
77	M	63	95.6	145	0.145		0.172		0.02		0.24		140	130	10.8		13.5		65.3		39.9	
79	M	66	4.47	51.4	0.147		0.166		0.34		0.90		215	220	24.2		25.3		57.5		71.5	
82	F	50	81.4	69.6	1.09		0.442		0.42		4.14		300	255	11.5		8.25		380		366	
83	F	72	121	269	0.117		0.210	0.248	0.28		0.37	0.58	137	197	15.4		15.0	14.8	261		207	311
84	F	51	77.2	56.6	0.449		0.352		0.58		0.49		256	212	13.7		13.6		293		359	
85	M	71	110	105	0.365		0.267		0.41		0.66		228	277	10.3		9.36		434		265	
86	F	59	30.9	55.3	0.352		0.309		0.85		0.94		372	317	10.2		9.33		244		247	
87	F	71	295		0.450		NSC		0.93		NSC		147	NSC	13.1		NSC		75.7		NSC	
88	M	77	48.1		0.496		NSC		2.24		NSC		197	NSC	13.2		NSC		122		NSC	
89	M	18	23.5	53.3	0.394		0.437		1.40		11.7		395	390	12.9		16.4		278		290	
90	M	69	119	126	0.355	0.377	0.313	0.273	4.55		1.62	0.66	403	590	14.0		7.99		1320	1400 718	826	
91	F	69	84.0	54.7	0.386		0.408		1.88		1.20		300	285	15.1		15.2		229		268	
92	M	54	46.4	137	0.593		0.852		0.79		0.72		213	148	15.5		11.6		527		335	
93	M	62	62.4	65.5	0.319		0.322		0.50		1.24		167	253	7.77		18.7		152		142	
94	M	58	253	175	0.473		0.735		0.79		0.63		266	231	12.9		14.0		114		206	
96	F	56	107	7.8	0.268		0.259		0.16		0.14		295	235	20.3		18.3		154		276	
97	F	61	69.4	33.6	0.205		0.163		1.44		1.36		150	195	21.2		18.3		267		71.0	
98	M	65	224	386	0.180		0.340		0.18		2.20		160	120	8.30		19.1		245		90.9	
99	F	58	190	76.8	0.160		0.238		0.12		0.16		167	137	12.0		12.0		1861		772	
100	F	57	22.6	59.4	0.431		0.342		1.04		0.74		256	187	13.9		9.16		177		137	
101	F	60	112	211	0.461		0.559		0.52		0.87		393	720	12.6		12.6		796		1108	
102	M	74	150	34.4	0.346		0.253		2.34		1.11		409	324	20.0		30.1		408		190	
103	F	64	35.1	50.1	0.279		0.214		2.08		1.32		1435	1291	17.4		19.6		852		812	
104	F	60	45.8	168	0.157		0.135		0.06		0.02		205	150	19.1		13.6		61.5		72.8	
105	M	51		142	NSC		0.083		NSC		0.04		NSC	40	NSC		1.75		NSC		3.09	
106	M	65	89.8	53.8	0.373		0.227		3.94		2.54		325	280	27.9		18.9		369		103	129
107	M	14	192	225	0.437		0.340		1.22		0.32		340	325	22.6		17.4		144		270	

continued...

TABLE G-3. (CONT'D)

Participant			Wet weight (g)		Cd (mg/g)*				Pb (µg/g)*				Zn (µg/g)*		Ca (mg/g)*				Fe (µg/g)*			
ID	Sex	Age	A	B	A	A	B	B	A	A	B	B	A	B	A	A	B	B	A	A	B	B
108	F	53	62.4	98.1	0.351		0.531		0.90		0.31		136	211	12.9		15.5		148		118	
109	F	58	36.2	68.5	0.164		0.181		0.36		0.64		118	183	11.6		15.4		241		223	
110	F	50	72.9	196	0.381		0.601		0.16		0.63		143	161	7.7		9.52		123		179	
111	F	18	7.54	16.5	0.497		0.413		0.77		0.51		233	178	12.6		11.8		250		189	
112	M	13	22.1	16.4	0.766		0.824		1.91		7.04		303	263	25.5		27.5		199		385	
113	M	15	18.5	55.3	1.02		1.53	1.67	7.98		10.1	10.6	288	388	16.0		17.2	17.5	834		817	696
114	M	67	83.3	128	0.373		0.436		2.52		2.18		288	298	8.69		13.6		363		472	
115	F	50	73.8	84.1	0.445		0.280		3.06		0.61		235	293	12.5		12.0		335		164	
116	M	12	37.4	62.6	0.832		0.686		4.55		1.48	0.82	253	328	21.8		27.1		274		338	
117	M	77		130	NSC		0.299		NSC		1.66	1.56	NSC	355	NSC		12.2	13.3	NSC		178	112
118	M	15		81.4	NSC		0.334		NSC		3.20		NSC	248	NSC		12.9		NSC		154	
119	F	67	39.0	92.4	0.306		0.289		0.610	1.04	0.460	1.30	318	418	15.6		14.3		234		201	
120	M	64	70.9	94.9	0.275		0.302		2.06		1.23		283	320	19.3		18.5		54.4		150	
122	M	59	77.3	41.2	0.199		0.157	0.149	4.83		1.31		113	82	13.7		10.1	11.5	293		142	168
124	F	50	135	229	0.169		0.225		0.81		0.91		303	388	19.7		21.0		113		149	
125	F	50	92.2	148	0.363		0.361		1.01		1.23		202	197	11.4		9.30		181		298	
126	M	64	73.3	59.2	0.277		0.269		0.51		1.81		115	177	9.04		15.4		289		389	
127	M	14	31.0	45.5	2.63		1.34		1.92		1.65		274	227	10.9		11.2		332		368	
128	M	51	81.0	187	0.593		0.453		2.18		3.09			268	17.0		12.0		98.3		161	
129	M	64	159	158	0.667		0.400		1.23		0.87		268	174	8.95		5.56		221		209	
130	F	50	97.7	41.7	0.340		0.611		1.18		1.30		250	359	18.6		21.5		130		125	
132	F	63	47.4	55.3	0.250		0.270		0.67		0.57		194	209	12.4		15.9		121		72.4	
133	M	16	57.7	50.0	0.331	0.301	0.374		1.22	1.20	0.96		347	177	5.76	5.40	7.91		149	151	203	
134	M	52	26.9	57.2	0.293		0.588		1.51		1.51		276	268	22.4		15.9		266		181	
135	M	68	124	111	0.495		0.409		0.99		0.81		360	300	18.3		16.2		329		394	
136	F	17	119	1.05	0.530		ISS		1.24		ISS		357	ISS	10.4		ISS		222		ISS	
137	F	18	80.8	84.8	0.552		0.624		1.68		2.14		276	345	15.9		16.4		109		162	
138	M	53	110	76.6	0.131		0.137		0.30		0.30		153	45	4.66		5.51		116		67.5	
139	F	54	39.0	43.9	0.256		0.196		1.55		1.19		260	198	18.6		13.9		78.4		217	
140	F	78	164	94.2	0.277		0.403		0.60		1.00		179	144	12.8		13.9		217		520	
141	F	59	77.8	96.6	0.293		0.255		1.74		1.03		182	193	6.74		7.63		246		143	
142	M	63	27.1	96.2	0.295		0.323		1.61		1.37		413	468	11.9		12.2		432		111	
143	M	59	59.2	137	0.543		0.733		2.13		2.04		479	569	11.2		16.0		181		127	
144	M	51	51.1	48.4	0.310		0.450		0.93		1.06		243	273	19.4		19.2		95.8		90.5	
201	M	66	66.5	66.6	0.309		0.326		188		3.15		533	377	36.6		28.0		573		530	
202	F	70	38.0	78.3	0.321		0.355		0.67		0.91		351	301	27.7		28.9		514		438	
203	F	58	74.8	177	0.276		0.292		1.03		1.53		535	509	36.2		27.7		95.5		415	
204	F	56	102	58.4	0.637		0.698		1.30		1.25		515	468	27.3		26.9		584		525	
205	M	77	57.5	171.0	0.601		0.72		0.98		0.005		300	219	38.3		27.8		240		325	
206	F	16	24.3	127	0.522		0.444		1.10		0.31		255	196	18.3		13.4		285		217	
207	F	64	78.2	258	0.244		0.223		26.0		8.00	2.57	741	693	58.1		50.4		206		173	
208	F	69	327	451	0.283		0.275		0.31		2.03		269	145	15.7		12.1		36.5		42.5	
209	M	12	55.3	32.8	0.347		0.432		0.23		0.33		315	365	34.2		31.6		322		154	
210	F	15	133	19.6	1.00		1.69		1.38		1.97		415	538	25.2		27.6		575		634	
211	F	14	69.0	78.5	0.51		0.155		0.12		0.74		156	306	7.81		28.6		171		96.5	
212	M	13	128	67.7	0.838		0.492		134		0.04		375	360	27.0		18.3		208		412	

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TABLE G-3. (CONT'D)

Participant			Wet weight (g)		Cd (mg/g)*				Pb (μg/g)*				Zn (μg/g)*		Ca (mg/g)*				Fe (μg/g)*			
ID	Sex	Age	A	B	A	A	B	B	A	A	B	B	A	B	A	A	B	B	A	A	B	B
213	M	17	38.7	15.5	0.282		0.241		0.40		0.49		297	212	35.7		33.1		40		257	
214	M	55	40.8	175	0.148		1.97		0.72		56.0		198	441	29.3		25.3		122		646	
215	F	12	32.7	270	0.142		0.404		0.58	0.59	1.17		135	277	10.9		11.1		13		120	
216	M	71	99.0	63.5	0.427		0.454		0.92		1.14		150	187	12.7		11.8		481		485	
217	M	13	78.3	66.3	0.247		0.324		1.22		1.24		445	575	36.2		44.8		223		638	
218	F	17	63.8	42.6	0.459		0.524		1.47		1.05		346	412	24.7		31.1		157		176	
219	F	15		68.6	NSC		0.285		NSC		0.85		NSC	287	NSC	18.1		NSC		70.5		
221	F	18	23.4	91.3	0.526		0.873		1.13		212		297	375	31.2		15.0		317		356	
222	M	16	37.0	82.3	0.433		0.417		0.50		0.66		239	265	8.70		10.7		82		265	
223	F	18	26.4	8.4	0.723		0.641		0.87		1.48		444	474	22.3		23.3		729		224	
224	F	52	200	66.9	0.354		0.327		0.80		1.68		287	336	27.2		29.2		179		73	
225	M	50	267	97.8	0.290		0.456		1.88		1.03		333	295	25.2		13.3		89		79.5	
226	F	14	217	349	0.069		0.227		0.30		0.47		140	190	5.40		7.33		77.5		87.5	
227	F	59	37.0	48.7	0.413		0.442		10.8		35.8		315	342	28.5		25.5		248		448	
228	F	16	26.3	34.3	0.453		0.551		1.88		12.5		242	217	20.3		14.4		517		1540	
229	M	73	108	25.4	0.536		0.590		4.60		4.67		381	385	22.7		23.3		295		282	
230	M	57	26.6	105	0.350		0.265		5.27		4.77		389	283	25.0		23.9		88.5		289	
231	M	12	43.8	26.1	1.09		0.931		0		0.67		680	530	14.4		17.3		838		588	
232	M	61	208	266	0.168		0.209		0		0		170	290	20.3		20.1		27.5		273	
233	M	56	47.6	67.9	0.546		0.455		2.96		2.79		360	310	15.1		11.1		453		428	
234	M	51	126	112	0.443		0.360		1.57		1.17		480	360	20.2		16.8		77.5		22.5	
235	F	16							-----No Sample Collected-----													
236	M	12	83.3	38.7	0.345		0.406		0.99		1.03		245	220	17.8		14.0		32.5		283	
237	F	18	65.3	30.5	0.319		0.327		1.53		1.05		545	420	34.8		26.3		82.5		233	
238	F	16	68.3	66.4	0.424		0.313		10.4		11.2		475	370	15.5		12.1		478		328	
239	F	56	52.7	145	0.508		0.198		0		0.47		355	250	14.2		12.8		328		77.5	
240	M	67	143	65.1	0.352		0.510		7.10		21.2		215	280	13.9		15.4		403		413	
241	M	14	96.9	208	0.560		0.699		1.04		1.19		450	455	18.6		21.3		92.5		123	
242	F	58	117	70.0	0.238		0.201		0.99		4.86		235	390	17.4		18.3		7.5		328	
243	M	14	54.2	189	0.853		0.377		1.98		0.48		410	280	9.73		9.05		478		228	
244	F	80	81.6		0.219		NSC		0.86		NSC		140	NSC	8.98		NSC	148			NSC	
245	F	17	34.5	24.5	0.338		0.260		0.84		0.42		230	210	9.91		13.9		128		2.5	
246	F	17	114	32.5	0.205		0.145		1.01		0.95		275	268	28.9		22.4		96.6		68.5	
247	M	14	216	24.6	0.397		0.502		12.8		0.83		433	385	13.0		16.3		314		205	
248	F	74	109	115	0.088		0.130		0		1.38		142	264	74.5		20.1		181		330	
249	F	83	162	147	0.142		0.237		1.89		1.34		176	204	14.9		15.3		183		65.4	
250	F	83	109	157	0.158		0.128		6.64		2.94		1326	1298	22.6		22.8		401		421	
251	M	17	109		0.408		NSC		0.988		NSC		437	NSC	27.2		NSC		80.1		NSC	
252	M	60	78.1	141	0.429		0.323		0.798		0.993		313	467	13.0		10.6		238		209	
253	M	14	54.8	20.7	0.490		0.293		1.18		0.763		388	223	19.3		21.7		390		38.5	
254	F	14	41.4	37.9	0.449		0.449		1.65		1.53		420	451	31.2		33.4		287		357	
255	M	15	121	50.7	0.422		0.442		178		6.34		439	492	16.1		11.6		1105		918	
256	M	12	43.9	74.4	0.524		0.604		17.5		2.48		422	413	26.1		22.4		198		155	
258	F	14	84.7	76.7	0.253		0.396		1.15		1.42		295	297	15.9		21.7		410		208	
259	F	17	44.5	21.1	0.308		0.257		0.928		0.823		280	443	17.3		19.1		301		1384	

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TABLE G-3. (CONT'D)

Participant			Wet weight (g)		Cd (mg/g)*				Pb (μg/g)*				Zn (μg/g)*		Ca (mg/g)*				Fe (μg/g)*			
ID	Sex	Age	A	B	A	A	B	B	A	A	B	B	A	B	A	A	B	B	A	A	B	B
260	F	16	75.9	32.9	0.492		0.357		1.39		0.738		538	469	18.2		15.4		549		415	
261	F	51	204	159	0.271		0.209		1.02		1.40		238	233	17.0		17.6		142		152	
262	M	18	122	94.1	0.304		0.307		0.65		0.54		263	243	12.4		14.9		271		302	
263	F	54	96.2	43.8	0.306		0.342		106		8.00		358	438	15.9		19.2		155		110	
264	M	78	65.8	133	0.756		0.744		0.62		0.84		288	278	13.9		15.8		687		691	
265	F	14	97.4		0.110		ISS		0.34		ISS		158	ISS	15.7		ISS		137		ISS	
266	M	17	107	121	0.209		0.442		1.14		7.74		153	428	7.24		14.4		23.3		357	
267	F	69	95.2	25.9	0.219		0.177		0.575		0.605		308	283	16.5		14.3		2843		2586	
268	M	52	31.7	163	0.217		0.046		366		0.425		208	243	13.4		4.84		331		292	
269	F	16	27.9	33.4	0.753		0.614		0.77		0.91		353	293	20.5		19.4		415		533	
270	F	73	226	60.3	0.305		0.325		2.87		6.50		338	338	17.4		18.8		660		575	
271	F	16	43.0	50.3	0.210		0.356		0.61		1.00		203	288	6.25		8.18		105		512	
272	F	14	11.4	34.8	0.476		0.372		0.22		1.02		553	513	31.7		24.7		54.2		66.4	
273	M	84	133	130	0.343		0.248		1.44		1.17		218	203	10.3		8.17		1970		1420	
274	M	75	337	19.6	0.474		0.519		5.84		13.2		198	208	11.3		9.23		250		288	
275	F	12	21.8	92.2	0.210		0.223		0.85		0.61		198	198	13.2		10.1		55.9		54.2	
276	F	13	3.3	128	0.612		0.494		3.71		2.54		408	333	20.8		17.6		405		370	
277	M	80	277	112	0.671		0.598		0.88		1.09		268	228	21.2		20.6		203		179	
278	F	70	214	203	0.378		0.672		8.48	8.10	0.02		338	228	14.9		13.5		128		530	
279	M	76	223	225	0.453		0.504		0.56		0.85		268	273	25.7		18.6		270		519	
280	F	50	71.1		0.256		ISS		0.13		ISS		297	ISS	13.1		ISS		110		ISS	
281	M	15	223	58.5	0.422		0.621		0.30		3.52		178	378	10.9		36.7		70.0		76.2	
282	M	12	64.3	48.8	0.792		0.203		29.1		0.08		338	373	32.1		10.6		172		332	
283	F	16	14.7	31.9	0.727		0.813		0.82		0.72		378	393	34.7		30.8		380		602	
284	F	15	28.8	43.3	0.073		0.299		0.06		0.01		198	258	4.33		10.4		205		179	
285	M	17	39.9	143	0.279		0.409		0.86		0.56		333	263	16.4		34.2		22.6		93.1	
286	M	12	153	41.1	0.552		0.749		0.82		1.10		283	363	23.8		17.7		1891		2620	
287	M	13	51.1	25.7	1.00		0.263		0.47		5.20		223	298	22.3		17.5		80.7		189.1	
288	M	13	62.7	47.3	0.716		0.797		0.60		1.05		263	283	12.5		17.9		62.7		10.7	
289	M	13	41.9	63.2	0.125		0.532		0		1.45		233	218	22.7		21.5		574		400	
290	F	60	43.3	122	0.218		0.315		0.49		1.20		238	373	20.4		28.2		14.7		64.9	
291	F	63	18.2	46.4	0.810		0.858		1.27		1.31		433	493	16.3		18.6		256		223	
292	M	14		199	NSC		0.290		NSC		0		NSC	323	NSC		5.32		NSC		272	
293	F	16	19.1	28.9	0.685		0.667		2.78		6.15		438	403	10.2		10.5		453		583	
294	M	15	44.2	35.1	0.506		0.541		1.36		1.96		237	323	18.1		17.6		86		53	
295	M	14	146	109	0.403		0.407		1.92		0.85		468	423	31.0		28.3		256		560	
296	F	14	141	49.2	0.481		0.879		3.05		88.5		558	573	4.95		15.8		426		454	
297	M	13	81.6	64.9	0.640		0.623		2.04		2.45		493	418	7.17		7.13		493		349	
298	F	71	139	52.8	0.301		0.871		0.03		0.50		208	223	15.2		13.3		163		80	
299	F	58	83.7		0.647		NSC		5.65		NSC		478	NSC	15.9		NSC		381		NSC	
300	M	58	124	181	0.683		0.779		183		1.38		488	523	13.0		13.3		451		457	
301	M	14	18.5	40.5	0.541		0.426		0.83		0.79		553	328	13.0		10.1		497		433	
302	F	51	86.5	28.1	0.520		0.467		1.36		1.45		348	358	20.9		22.9		349		388	
303	F	16	42.5	32.4	0.617		0.596		1.69		0.81		498	503	22.1		28.7		229		106	
304	F	14	104	43.0	0.649		0.386		1.00		1.36		283	328	16.7		15.9		134		237	
305	M	51	56.2	36.2	0.386		0.338		2.66		1.67		338	383	24.6		22.1		276		64	
306	M	56	47.6	6.84	0.488		0.449		1.91		0.46		268	263	10.5		9.30		390		315	

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TABLE G-3. (CONT'D)

Participant ID	Sex	Age	Wet weight (g) A	Wet weight (g) B	Cd (mg/g)* A	Cd (mg/g)* B	Pb (µg/g)* A	Pb (µg/g)* B	Zn (µg/g)* A	Zn (µg/g)* B	Ca (mg/g)* A	Ca (mg/g)* B	Fe (µg/g)* A	Fe (µg/g)* B
307	M	57	54.4	69.9	0.189	0.124	0.75	1.22	178	183	11.0	9.30	251	195
308	M	59	97.1	90.8	0.232	0.198	0.09	1.38	473	363	7.65	13.0	232	194
309	F	58	148	104	0.311	0.308	0.97	1.24	353	397	13.0	14.7	257	217
310	F	17	70.5	27.9	0.270	0.269	3.51	1.42	308	283	20.5	20.0	139	91
311	M	68	40.9	66.2	0.365	0.284	8.41	1.23	308	288	13.8	12.2	200	216
312	F	12	245	16.8	0.225	0.233	1.46	0.04	273	263	11.0	14.3	156	191
313	M	86	114	73.0	0.182	0.133	20.2	0.35	498	488	21.3	9.72	305	305
314	M	64	167	49.6	2.20	0.364	0.43	1.00	543	333	18.8	19.2	765	62.5
315	M	18	53.2	101	0.392	0.495	0.13	2.03	388	408	14.3	13.4	248	262
316	M	16	138	93.3	0.354	0.357	0.06	0	278	308	12.0	16.2	436	297
317	F	13	44.9	28.6	0.225	0.004	0	0	193	97.5	12.0	3.18	200	68.2
318	F	50	15.2	95.9	0.287	0.333	0.21	1.56	318	263	8.81	12.3	129	506
319	M	53	90.6	183	0.587	0.509	0.72	0	318	328	17.3	14.1	172	247
320	M	63	16.6	37.3	0.322	0.272	8.78	4.74	378	348	14.5	13.7	369	360
321	F	15	31.6	132	0.296	0.199	1.06	0.56	268	213	11.3	10.6	237	246
322	F	18	106	109	0.567	0.386	0.33	0.50	338	403	12.7	17.3	184	114
324	F	51	104	54.2	0.276	0.125	0.31	0	315	235	16.0	15.5	99.0	75.7
325	M	18	79.7	59.3	0.290	0.149	0.10	0.28	625	370	11.3	16.6	351	122
326	M	17	20.4	54.7	0.146	0.150	0.12	0.15	165	160	13.7	13.7	29.1	25.6
327	F	78	206		0.420	ISS	0.95	ISS	590	ISS	13.0	ISS	295	ISS
328	M	73	-----No Sample Collected-----											
329	F	12	95.0	69.5	0.347	0.416	0.56	1.73	430	405	9.16	8.10	220	254
330	M	12	39.6	59.3	0.331	0.472	0.25	1.33	425	405	17.3	6.34	508	350
331	M	15	75.0	33.2	0.554	0.452	1.33	0.91	710	350	7.40	6.70	404	211
332	F	15	50.7	26.9	0.245	0.193	0.86	0.08	285	235	13.4	16.9	64.5	101
333	F	69	64.4	58.3	0.228	0.255	3.99	2.58	485	545	16.2	15.5	264	234
334	M	18	250	294	0.283	0.247	1.90	0.32	290	160	25.3	17.0	91.0	206
335	F	65	334	122	0.342	0.248	1.28	14.9	415	365	23.7	24.2	441	334
336	M	15	96.2	60.2	0.298	0.310	0.62	0	395	415	17.5	18.0	44	78
337	M	68	162	120	0.249	0.278	4.14	5.42	295	340	11.9	13.9	52.5	287
338	F	77	173		0.214	NSC	1.12	NSC	370	NSC	26.8	NSC	184	NSC
339	F	15	28.8	36.2	0.437	0.471	1.03	0.73	560	390	13.9	14.4	1288	829
340	M	66	111	53.3	0.465	0.301	25.6	1.19	430	495	20.1	17.0	158	211

* Dry Weight
NSC - No sample collected
ISS - Insufficient sample

APPENDIX H

DATA ANALYSIS RESULTS

The ANOVA data tables are presented in this appendix.

Table H-1. Analysis of Variance for Effects of Smoking on Cadmium in Urine in Urban Hispanics
Table H-2. Analysis of Variance for Effects of Smoking on Cadmium in Urine in Rural Blacks
Table H-3. Analysis of Variance for Effects of Smoking on Lead in Urine in Urban Hispanics
Table H-4. Analysis of Variance for Effects of Smoking on Lead in Urine in Rural Blacks
Table H-5. Analysis of Variance for Effects of Smoking on Cadmium in Blood in Urban Hispanics
Table H-6. Analysis of Variance for Effects of Smoking on Cadmium in Blood in Rural Blacks
Table H-7. Analysis of Variance for Effects of Smoking on Lead in Blood in Urban Hispanics
Table H-8. Analysis of Variance for Effects of Smoking on Lead in Blood in Rural Blacks

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TABLE H-1. ANALYSIS OF VARIANCE FOR EFFECTS OF SMOKING ON CADMIUM IN URINE IN URBAN HISPANICS

Source	df	SS	MS	F
Between groups	2	1.89	0.94	5.66*
Within groups	121	20.15	0.17	
Total	123	22.04		

Means (μg/L)

Nonsmokers	Current nonsmokers	Smokers
0.099	2.096	2.254

* Significant at 0.05 level.

TABLE H-2. ANALYSIS OF VARIANCE FOR EFFECTS OF SMOKING ON CADMIUM IN URINE IN RURAL BLACKS

Source	df	SS	MS	F
Between groups	2	0.77	0.39	3.91*
Within groups	134	13.24	0.10	
Total	136	14.01		

Means (μg/L)

Nonsmokers	Current nonsmokers	Smokers
0.553	0.553	0.954

* Significant at 0.05 level.

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TABLE H-3. ANALYSIS OF VARIANCE FOR EFFECTS OF SMOKING ON LEAD IN URINE IN URBAN HISPANICS

Source	df	SS	MS	F
Between groups	2	0.66	0.33	0.18
Within groups	119	218.86	1.84	
Total	121	219.52		

Means (μg/L)

Nonsmokers	Current nonsmokers	Smokers
3.096	2.56	3.254

TABLE H-4. ANALYSIS OF VARIANCE FOR EFFECTS OF SMOKING ON LEAD IN URINE IN RURAL BLACKS

Source	df	SS	MS	F
Between groups	2	0.12	0.06	0.05
Within groups	134	152.54	1.14	
Total	136	152.66		

Means (μg/L)

Nonsmokers	Current nonsmokers	Smokers
5.68	6.51	6.29

TABLE H-5. ANALYSIS OF VARIANCE FOR EFFECTS OF SMOKING ON CADMIUM IN BLOOD IN URBAN HISPANICS

Source	df	SS	MS	F
Between groups	2	0.073	0.036	1.27
Within groups	123	3.531	0.029	
Total	125	3.604		

Means (μg/dL)

Nonsmokers	Current nonsmokers	Smokers
0.178	0.139	0.206

TABLE H-6. ANALYSIS OF VARIANCE FOR EFFECTS OF SMOKING ON CADMIUM IN BLOOD IN RURAL BLACKS

Source	df	SS	MS	F
Between groups	2	0.074	0.037	1.00
Within groups	128	4.741	0.037	
Total	130	4.815		

Means (μg/dL)

Nonsmokers	Current nonsmokers	Smokers
0.131	0.106	0.138

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TABLE H-7. ANALYSIS OF VARIANCE FOR EFFECTS OF SMOKING ON LEAD IN BLOOD IN URBAN HISPANICS

Source	df	SS	MS	F
Between groups	2	2.21	1.10	2.88
Within groups	128	48.87	0.38	
Total	130	51.08		

Means (µg/dL)

Nonsmokers	Current nonsmokers	Smokers
8.50	12.18	11.59

6-1/2"
9-1/8"

TABLE H-8. ANALYSIS OF VARIANCE FOR EFFECTS OF SMOKING ON LEAD IN BLOOD IN RURAL BLACKS

Source	df	SS	MS	F
Between groups	2	4.27	2.13	3.40*
Within groups	122	76.47	0.63	
Total	124	80.73		

Means (µg/dL)

Nonsmokers	Current nonsmokers	Smokers
5.31	6.69	8.17

* Significant at 0.05 level.

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